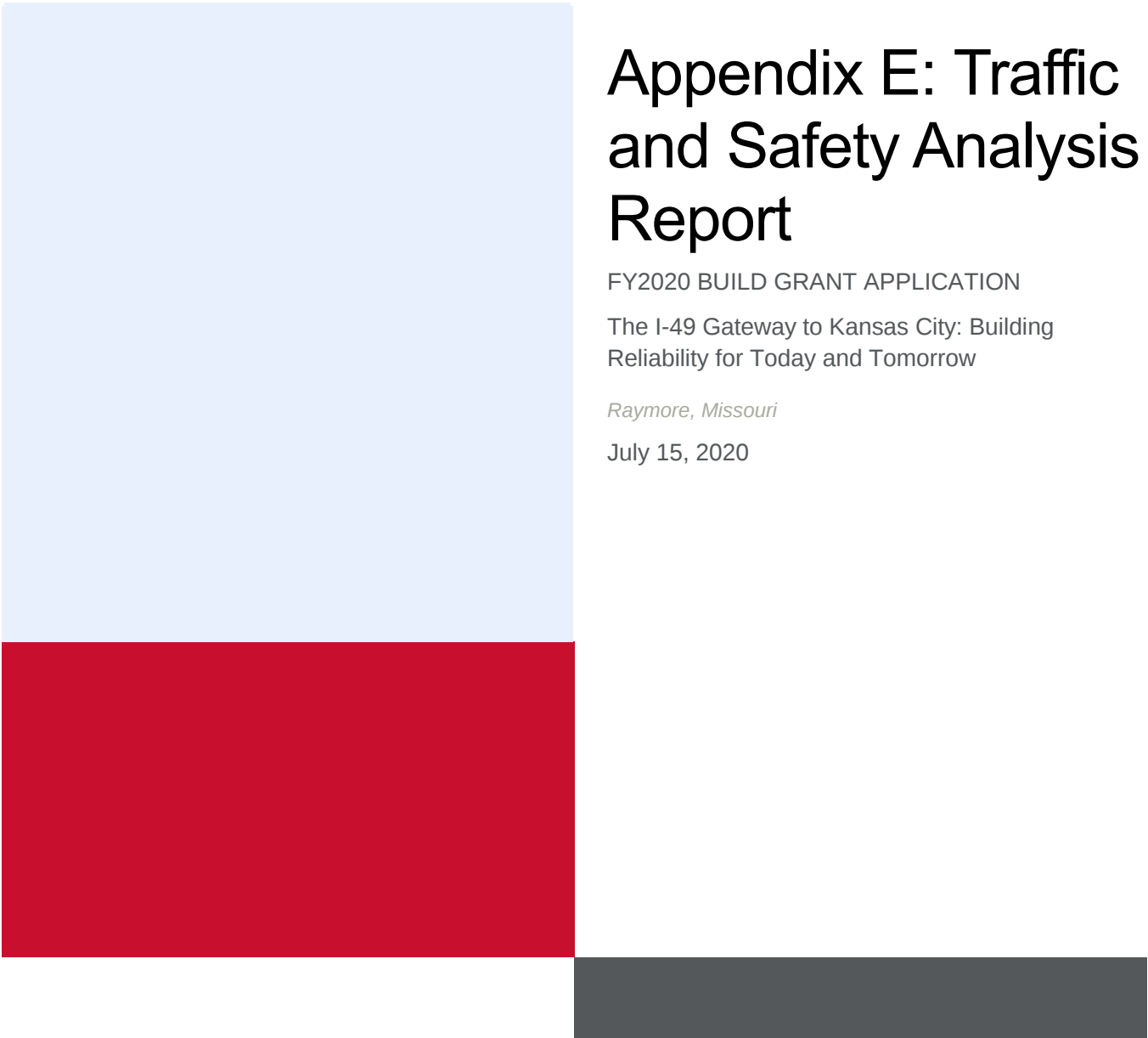


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Appendix E: Traffic and Safety Analysis Report

FY2020 BUILD GRANT APPLICATION

The I-49 Gateway to Kansas City: Building
Reliability for Today and Tomorrow

Raymore, Missouri

July 15, 2020

Contents

- 1. PROJECT INTRODUCTION.....3
- 2. DATA COLLECTION/ASSUMPTIONS4
- 3. FREEWAY (FREEVAL) ANALYSIS.....6
 - Existing Conditions FREEVAL Models 7
 - Opening Year (2023) FREEVAL Models 11
 - Forecast Year (2045) FREEVAL Models 11
 - FREEVAL Results Summary 14
- 4. INTERSECTION (SYNCHRO) ANALYSIS 14
 - Existing Conditions..... 14
 - Opening Year (2023)..... 15
 - Forecast Year (2045) 15
 - Synchro Results Summary..... 16
- 5. PREDICTIVE SAFETY ANALYSIS..... 18
 - Safety Analysis Approach 18
 - Modelling Approach..... 18
 - Existing Conditions Safety Analysis 20
 - Opening Year and Design Year Safety Performance 23
- 6. SUMMARY OF RESULTS AND CONCLUSIONS.....24

Tables

Table 1. Collected Data	4
Table 2. Freeway Facility LOS Criteria	6
Table 3. Suggested Peak Hour Factor	7
Table 4. Existing 2020 FREEVAL Results – I-49 Corridor	10
Table 5. Opening Year (2023) FREEVAL Results – I-49 Mainline.....	11
Table 6. Future Year (2045) FREEVAL Results – I-49 Mainline.....	13
Table 7. FREEVAL Results Summary (Forecast Year 2045)	14
Table 8. Synchro Results Summary	17
Table 9. Calibration Factors for the ISATe models	18
Table 10. Severity Distribution Factors (SDFs) – Freeway Segments.....	19
Table 11. Summary of Crashes from 2014-2018	20
Table 12. ISATe Existing Expected and Predicted Crashes	22
Table 13. ISATe HSM Predicted crashes for Opening Year (2023) and Design year (2045)	23

Figures

Figure 1. Project Location	3
Figure 2. Example I-49 FREEVAL Model Diagram of Traffic Volume Density.....	7
Figure 3. Illustrative FREEVAL Results: Existing 2020 I-49 Southbound PM Peak-Period Baseline (No incidents or weather events)	9
Figure 4. Percentage of Crash Types on I-49 Study Corridor.....	20
Figure 5. 2014-2018 Average Crash Rates for I-49, State Interstate and Freeway System	21

Attachments

- Attachment E-1: FREEVAL Input
- Attachment E-2: FREEVAL Results
- Attachment E-3: Speed Data
- Attachment E-4: Synchro Analysis

1. PROJECT INTRODUCTION

This supplemental report describes the operational and safety impacts of the potential improvements along I-49 in Cass County as referenced in the FY2020 Build Grant Application; *The I-49 Gateway to Kansas City: Building Reliability for Today and Tomorrow*. As stated in the application, the project limits are along a 4.2 mile segment of I-49 that is adjacent to the cities of Raymore and Belton in Cass County, MO, just southeast of Kansas City, MO as shown in **Figure 1**.

Figure 1. Project Location



This section of I-49 is a major bottleneck in the southern portion of the bi-state Kansas City metro area – hampering regional commute traffic, vital interstate freight commerce, and travel to and from rural areas. Congestion regularly extends back for one to two miles during peak hours. The project described in the application aims to resolve freight bottlenecks and congestion issues by increasing capacity along the segment. Further description of the project scope and limits are detailed in the grant application. Anticipated traffic operations of said improvements were analyzed using the latest industry standard traffic analysis software (FREEVAL and SYNCHRO) and data obtained by local agencies and private data collectors. Safety along the corridor was reviewed using the Enhanced Interchange Safety Analysis (ISATe) tool.

2. DATA COLLECTION/ASSUMPTIONS

In order to replicate existing traffic conditions and to forecast future trends in traffic along I-49, the data summary shown in **Table 1** was collected for the preparation of the traffic and safety operational analysis.

Table 1. Collected Data

Obtained From	Data Collected	Origin Date
Missouri Department of Transportation	Average Annual Daily Traffic (AADT) and Hourly Traffic Counts including vehicle classification data.	2014 to 2017
Missouri Department of Transportation	Traffic Crash Data	2014 to 2018
Missouri Department of Transportation	Regional Integrated Transportation Information System (RITIS) Speed Data	2017
StreetLight Data, Inc	Origin-Destination Data used to estimate Turning Movement Volumes (AM/PM Peak Hour)	2019
Operation Green Light (MARC Initiative)	Signal Timings (Synchro Files) for 163 rd Street Interchange	2015
HDR, Inc	Signal Timings (Synchro Files) for Route 58 Interchange	2019
Mid-America Regional Council (MARC)	2015/2050 Bi-Directional Travel Demand Model Traffic Projections (AM, PM, and Daily)	2015 (2015 Model) / 2020 (2050 Model)

Missouri Department of Transportation (MoDOT): MoDOT provided crash data, traffic counts (AADT and hourly), vehicle classification data, and observed along the corridor speeds. Between 2014 and 2017, daily traffic volumes along I-49 grew at an average annual rate of 2.15 percent. This growth rate was used to inflate the 2017 hourly traffic counts to 2020 base year volumes for further operational analysis.

Streetlight Data, Inc.: Turning-movement volumes were derived from origin-destination data obtained from StreetLight Data, Inc. for the signalized ramp terminal intersections at I-49 and 163rd Street and at N. Cass Parkway. StreetLight Data collects mobile source probe data and uses analytical processes to develop traffic databases that include speed data, Average Daily Traffic (ADT) volumes, turning movement counts, origin-destination data, and other traffic characteristics. StreetLight Data was utilized in lieu of collecting actual traffic volumes due to the COVID-19 pandemic. Data for average weekdays in May 2019 was obtained in hourly increments. May 2019 was chosen to match the time period in which traffic data was collected for the Route 58 Traffic Relief project described later in this document. Based on this data, it was determined that the peak traffic periods occur from 7 – 8 AM and 5 – 6 PM. Turning-movement volume data derived from the StreetLight data is included separately in BUILD Grant Application **Appendix E**.

Operation Green Light: Operation Green Light (OGL) is a cooperative effort to improve the coordination of traffic signals and incident response on major routes throughout the Kansas City area on both sides of the state line. OGL maintains Synchro models with current signal timing for traffic

signals under their jurisdiction. OGL provided AM and PM Peak Hour Existing Conditions Synchro models for the interchange at I-49 and 163rd Street. These models were utilized in the 2020 Existing Conditions analysis for this study.

HDR, Inc.: HDR was hired in 2019 by the City of Belton to perform a traffic relief project on MO Route 58 west of the I-49 ramp intersections. The Existing Conditions Synchro models developed for that project (utilizing 2015 OGL base models) included the interchange at I-49. These models were utilized in the 2020 Existing Conditions analysis for this study. The interchange ramp termini intersections at I-49 and N. Cass Parkway were added to these existing conditions Synchro models in order to be used for the I-49 Gateway analysis.

Mid-America Regional Council (MARC): In order to analyze future conditions at each of the study freeway segments and ramps, forecasted volumes were developed for the 2045 horizon year. To aid in developing these forecasted turning movements, 2015 and 2050 Travel Demand Model outputs for the AM and PM Peak hours, including Daily, were obtained from MARC. Model outputs were provided at the segment level for each direction. Model outputs at the intersection turning-movement level were not available.

Using the AM and PM peak hour segment volumes from the base year (2015) and 2050 models, segment-level annual growth rates were calculated, where possible. The growth rate percentages ranged from 0% to 2.23%, with the average for the study area equaling approximately 0.82% annually over the 25-year period. To forecast volumes at each interchange, the growth rates at all four ramps were averaged. To forecast the volumes for each freeway segment, the northbound and southbound growth rates were averaged.

The calculated growth rates were then applied to the corresponding approach volumes of the previously calculated 2020 existing volumes. The result was a set of raw, unbalanced, future (2023 and 2045) ramp and freeway segment volumes. Further adjustments were then made to balance the movements between adjacent segments and ramps, including the at-grade ramp intersections.

3. FREEWAY (FREEVAL) ANALYSIS

The FREEVAL analysis tool, version 1.01, was used to evaluate operations along I-49 for the study scenarios. FREEVAL implements the Highway Capacity Manual, 6th Edition, (HCM) methods for analyzing freeway segments, merge/diverge areas, and weaves. FREEVAL is well-suited for evaluating capacity-increasing strategies such as those being proposed for I-49. HDR calibrated and utilized FREEVAL to assess speed, travel time, and system reliability measures. FREEVAL inputs include traffic volumes in terms of flow rate, geometry (lanes, lane widths, weaving sections), weather, and incident data.

FREEVAL outputs include density measurements and levels of service (LOS). Density measurement outputs are based on *Exhibit 10-6* in the HCM (page 10-15). This manual provides procedures for the analysis of both urban and rural freeway facilities. For the purposes of this study urban freeway facility parameters were used. LOS categories (based on the density thresholds) range from LOS “A” (low density) to “F” (excessive density) as shown **Table 2**.

Table 2. Freeway Facility LOS Criteria

Freeway Facility Density (pc/mi/ln)	
Urban	LOS
≤ 11	A
> 11 - 18	B
> 18 - 26	C
> 26 - 35	D
> 35 - 45	E
> 45 *	F

*or any component segment v/c ratio > 1.00

Counts: The models were developed based on MoDOT and StreetLight traffic count data described earlier. To account for both sets of data, the models were created to represent a typical weekday in early November without any incidents or weather events. To replicate 2020 volumes, the count data was also adjusted by the 2.15-percent growth rate derived from AADT data provided by MoDOT as mentioned earlier in this document.

Speeds: Freeway free-flow speeds (FFS) were obtained using the off-peak speeds along the corridor found within the RITIS data.

Volume Balancing: Volumes were balanced along the I-49 corridor (155th Street to North Cass Parkway) to account for imbalances between both datasets. The mainline volumes within the MoDOT dataset between N Cass Parkway and MO-58 were maintained while counts at the interchanges were balanced using the existing turning movement patterns. Volumes on the remaining mainline segments were developed by adding and subtracting ramp volumes as appropriate. Detailed calculations of this exercise can be found as a supporting document alongside this report within **Appendix E** of the BUILD Grant application.

Analysis Periods: The AM and PM 2020 balanced peak hour segment volumes were used in the base year condition FREEVAL models. Models also included one hour before and after the peak hour to analyze the time leading up to and after the peak periods. For these supplemental hours, the MoDOT hourly counts were used. The build and future year models utilized the same volume data sets grown at the rate identified by the MARC Travel Demand Model. Flow rates and other model inputs for each scenario can be found in Attachment E-1.

Peak Hour Factor (PHF): The PHF indicates when the peak 15 minutes of traffic occurs during the peak hour, and also indicates how consistent the flow of traffic is during the peak hour. To accurately depict the flow of traffic, PHFs were chosen based on HCM and Synchro methodology, then applied to the peak hour volume being analyzed (combination of MoDOT and Streetlight Data data). The “arrival profiles” of these flow rates are dependent on and calculated from the PHF chosen from **Table 3**; the calculations can be viewed as an attachment to this document. For the “supplemental hours” described above, a more uniform a PHF of 0.95 was used.

Table 3. Suggested Peak Hour Factor

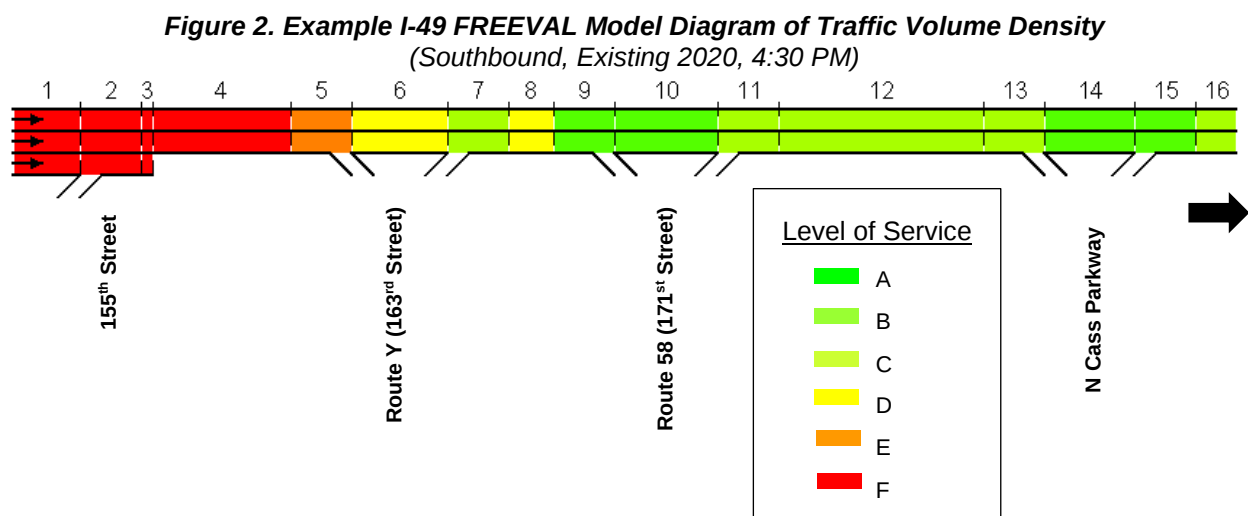
Suggested PHF*		
Total Segment Volume		PHF
0	50	0.78
51	100	0.83
101	200	0.87
201	500	0.92
501	1000	0.93
1001	2000	0.95

*HCM SYNCHRO recommended values.

Existing Conditions FREEVAL Models

Existing traffic conditions on I-49 from north of the Route Y (163rd Street) interchange to south of the N. Cass Parkway interchange were modeled using FREEVAL. Section types, lane configurations, segment lengths and other geometric features were coded using current aerial images. Existing base models were calibrated to match the observed speeds of traffic during the peak hour periods found in the RITIS data. Calibrating the FREEVAL models to the collected speeds is crucial to accurately show bottlenecks and congestion observed in the field. Seed capacity adjustment factors were also adjusted to further match observed speeds and travel times. An example FREEVAL model diagram for southbound I-49 is illustrated in **Figure 2**.

This particular example shows the density-based level of service (LOS) for baseline (existing) 2020 conditions with no incidents or weather at 4:30 PM. As shown, the northern portion of the corridor (where three lanes reduce to two lanes) operates at poor or failing levels of service (e.g., segments shaded red).



FREEVAL models were created for the AM and PM peak periods in both directions of I-49. The northbound models analyze the time periods from 6:00 am to 9:00 am and 3:00 pm to 6:00 pm while the southbound models analyze 6:00 am to 9:00 am and 3:00 pm to 7:00 pm.

FREEVAL requires that all traffic volumes be input as 15-minute demand flow rates, expressed in vehicles per hour (vph). Therefore, both peak period direction models included twelve 12-minute periods, with the exception of the southbound PM models which showed sixteen 15-minute periods. The southbound PM model was extended by one hour to allow for the substantial queueing (beyond the I-470 / I-435 interchange) occurring in the 2023 and 2045 No-Build models to subside. These adjustments are consistent with Highway Capacity Manual Guidance (Chapter 10), which indicates that the time-space domain of freeway facility analyses should be free of congestion at the “boundaries” (the start and end times of the analysis, and the beginning and end of the physical extents of the facility).

Furthermore, the study team capped the flow rates within the 2023 and 2045 No-Build models to only allow queue lengths to reach the I-470 / I-435 system interchange, 4.5 miles north of the study corridor. It was assumed that, if queue lengths were to extend to this point, motorists would ultimately use the system interchange to find alternative regional routes.

Figure 3 shows key outputs from FREEVAL, in this case for the southbound PM peak period. Checks of the baseline speed and corridor travel time results indicated that both the AM and PM models were representative of a typical weekday in November 2020 without any incidents (including shoulder blockages) or weather events.

Seed capacity adjustment factors were calibrated to match the RITIS speed data provided by MoDOT. Consistent with observations of existing conditions (including typical delays shown by Google Maps), FREEVAL indicates that density along the corridor reaches its peak during the AM peak period for the northbound direction and in the PM peak period for the southbound direction. Poor levels of service (LOS) and volume-to-capacity (V/C) ratios at or nearing 1.0 can be found along the segment of I-49 from 155th Street to MO-58 interchange in the northbound direction (AM Peak Period) and from 155th Street Interchange to the 163rd Street interchange in the southbound direction (PM Peak Period). Detailed FREEVAL results can be found in **Table 4**.

**Figure 3. Illustrative FREEVAL Results: Existing 2020 I-49 Southbound PM Peak-Period Baseline
(No incidents or weather events)**

Speeds																
Analysis Period	Seg. 1	Seg. 2	Seg. 3	Seg. 4	Seg. 5	Seg. 6	Seg. 7	Seg. 8	Seg. 9	Seg. 10	Seg. 11	Seg. 12	Seg. 13	Seg. 14	Seg. 15	Seg. 16
#1 15:00 - 15:15	58.7	57.8	57.8	58.4	55.1	54.2	58.6	66.0	56.5	66.6	61.8	70.0	59.4	69.5	62.2	69.0
#2 15:15 - 15:30	58.7	57.8	57.8	58.4	55.6	54.7	59.2	66.9	57.1	67.4	61.8	70.0	59.4	69.5	62.2	69.0
#3 15:30 - 15:45	50.0	39.6	39.6	57.4	53.8	52.9	58.3	65.8	56.5	66.4	61.1	69.0	58.8	68.5	61.4	68.0
#4 15:45 - 16:00	42.8	36.5	27.5	36.1	55.1	54.0	58.5	66.0	56.5	66.5	61.1	69.0	58.8	68.5	61.4	68.0
#5 16:00 - 16:15	44.6	30.1	24.6	33.5	55.2	53.5	58.1	65.5	56.5	66.0	61.6	69.9	59.2	69.5	62.0	69.0
#6 16:15 - 16:30	35.7	24.5	24.5	33.5	55.2	53.8	58.0	65.4	56.5	66.0	60.9	69.0	58.5	68.5	61.2	68.0
#7 16:30 - 16:45	18.9	24.3	30.0	40.4	55.1	53.4	57.8	65.0	56.3	65.9	61.5	69.8	59.1	69.5	61.8	68.9
#8 16:45 - 17:00	19.1	24.6	40.9	40.6	55.1	53.7	58.0	65.4	56.5	66.0	61.6	69.9	59.2	69.5	61.9	68.9
#9 17:00 - 17:15	19.5	26.0	28.9	34.7	55.5	54.3	59.0	66.6	56.7	67.6	61.9	70.0	59.1	69.5	62.3	69.0
#10 17:15 - 17:30	18.9	24.5	24.2	33.9	55.0	54.6	58.4	65.9	56.1	66.6	61.9	70.0	59.2	69.5	62.3	69.0
#11 17:30 - 17:45	18.9	24.3	24.2	33.6	55.0	54.7	58.5	66.0	56.1	66.6	61.9	70.0	59.2	69.5	62.3	69.0
#12 17:45 - 18:00	18.7	24.6	24.2	33.9	55.0	54.7	58.5	66.0	56.1	66.6	61.9	70.0	59.2	69.5	62.3	69.0
#13 18:00 - 18:15	17.6	17.6	17.3	33.5	54.6	57.7	59.2	66.1	56.4	66.6	62.1	70.0	59.3	69.5	62.5	69.0
#14 18:15 - 18:30	23.0	17.6	17.0	33.4	54.6	57.8	59.2	66.1	56.4	66.6	62.1	70.0	59.3	69.5	62.5	69.0
#15 18:30 - 18:45	62.4	53.3	38.6	46.9	54.8	60.0	59.6	66.1	56.6	66.6	62.2	70.0	59.4	69.5	62.6	69.0
#16 18:45 - 19:00	62.4	59.0	62.0	62.7	55.0	62.0	59.9	66.1	56.9	66.6	62.3	70.0	59.4	69.5	62.7	69.0

Density-Based LOS																
Analysis Period	Seg. 1	Seg. 2	Seg. 3	Seg. 4	Seg. 5	Seg. 6	Seg. 7	Seg. 8	Seg. 9	Seg. 10	Seg. 11	Seg. 12	Seg. 13	Seg. 14	Seg. 15	Seg. 16
#1 15:00 - 15:15	C	C	C	E	D	D	C	C	B	B	B	B	B	B	B	B
#2 15:15 - 15:30	C	C	C	E	D	D	C	C	B	B	B	B	B	B	B	B
#3 15:30 - 15:45	D	C	E	E	E	D	C	C	B	B	B	B	B	B	B	B
#4 15:45 - 16:00	D	E	F	F	D	D	C	C	B	B	B	B	B	B	B	B
#5 16:00 - 16:15	D	F	F	F	D	D	C	D	B	B	B	B	B	B	B	B
#6 16:15 - 16:30	E	F	F	F	D	D	C	D	B	B	C	C	B	B	B	C
#7 16:30 - 16:45	F	F	F	F	E	D	C	D	B	B	C	C	C	B	B	C
#8 16:45 - 17:00	F	F	E	F	D	D	C	D	B	B	C	C	B	B	B	C
#9 17:00 - 17:15	F	F	F	F	D	D	C	C	B	B	B	B	B	B	B	B
#10 17:15 - 17:30	F	F	F	F	D	D	C	C	B	B	B	B	B	B	B	B
#11 17:30 - 17:45	F	F	F	F	D	D	C	C	B	B	B	B	B	B	B	B
#12 17:45 - 18:00	F	F	F	F	D	D	C	C	B	B	B	B	B	B	B	B
#13 18:00 - 18:15	F	F	F	F	D	C	C	C	B	B	B	B	B	B	B	B
#14 18:15 - 18:30	F	F	F	F	D	C	C	C	B	B	B	B	B	B	B	B
#15 18:30 - 18:45	C	C	D	E	D	C	C	C	B	B	B	B	B	B	B	B
#16 18:45 - 19:00	C	B	C	D	D	C	B	C	A	A	B	B	B	B	B	B

Queues (traffic backing up from one 15 minute period to the next, or one segment to the next)																
Analysis Period	Seg. 1	Seg. 2	Seg. 3	Seg. 4	Seg. 5	Seg. 6	Seg. 7	Seg. 8	Seg. 9	Seg. 10	Seg. 11	Seg. 12	Seg. 13	Seg. 14	Seg. 15	Seg. 16
#1 15:00 - 15:15	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
#2 15:15 - 15:30	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
#3 15:30 - 15:45	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
#4 15:45 - 16:00	47%	100%	100%	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
#5 16:00 - 16:15	0%	41%	100%	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
#6 16:15 - 16:30	53%	100%	100%	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
#7 16:30 - 16:45	100%	100%	0%	67%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
#8 16:45 - 17:00	100%	100%	0%	70%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
#9 17:00 - 17:15	100%	100%	100%	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
#10 17:15 - 17:30	100%	100%	100%	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
#11 17:30 - 17:45	100%	100%	100%	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
#12 17:45 - 18:00	100%	100%	100%	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
#13 18:00 - 18:15	100%	100%	100%	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
#14 18:15 - 18:30	0%	56%	100%	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
#15 18:30 - 18:45	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
#16 18:45 - 19:00	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Note: Segment IDs are as identified in Table 4.

Table 4. Existing 2020 FREEVAL Results – I-49 Corridor

Description	Type	AM Peak Period		PM Peak Period	
		Density (veh/mi/lane)	V/C*	Density (veh/mi/lane)	V/C*
Southbound					
1. 155th St Off-ramp to On-ramp	Basic	9.5	0.43	49.8	0.87
2. 155th St On-ramp	On Ramp	8.8	0.48	47.3	0.95
3. North of 163rd St 3-2 Transition	Basic	9.8	0.47	49.0	1.00
4. North of 163rd St	Basic	14.7	0.47	53.4	0.92
5. 163rd St Off-ramp	Off Ramp	14.0	0.48	34.3	1.00
6. 163rd St Off-ramp to On-ramp	Basic	10.1	0.41	27.3	0.85
7. 163rd St On-ramp	On Ramp	10.2	0.38	24.6	0.82
8. North of MO-58	Basic	10.4	0.34	24.6	0.73
9. MO-58 Off-ramp	Off Ramp	0.34	0.39	15.5	0.84
10. MO-58 Off-ramp to On-ramp	Basic	6.3	0.24	13.8	0.56
11. MO-58 On-ramp	On Ramp	8.6	0.24	18.0	0.55
12. North of N Cass Pkwy	Basic	7.3	0.24	16.1	0.55
13. N Cass Pkwy Off-ramp	Off Ramp	6.9	0.27	17.4	0.60
14. N Cass Pkwy Off- to On-ramp	Basic	6.9	0.23	14.5	0.51
15. N Cass Pkwy On-ramp	On Ramp	8.2	0.35	17.1	0.71
16. South of N Cass Pkwy	Basic	7.8	0.27	16.0	0.55
Northbound					
1. South of N Cass Pkwy	Basic	16.1	0.59	12.0	0.37
2. N Cass Pkwy Off-ramp	Off Ramp	16.3	0.62	11.5	0.40
3. N Cass Pkwy Off- to On-Ramp	Basic	15.1	0.58	10.5	0.37
4. N Cass Pkwy On-ramp	On Ramp	18.2	0.63	12.5	0.55
5. North of N Cass Pkwy	Basic	17.2	0.60	11.8	0.41
6. MO58 Off-ramp	Off Ramp	17.0	0.58	10.6	0.48
7. MO-58 Off-ramp to On-ramp	Basic	15.1	0.58	9.8	0.39
8. MO-58 On-ramp	On Ramp	26.5	1.00	17.7	0.54
9. North of MO-58	Basic	30.3	0.90	17.1	0.54
10. 163rd St Off-ramp	Off Ramp	26.7	0.92	16.8	0.54
11. 163rd St Off-ramp to On-ramp	Basic	27.9	0.90	15.5	0.48
12. 163rd St On-ramp	On Ramp	34.3	1.00	23.2	0.73
13. North of 163rd St	Basic	38.5	0.98	22.7	0.69
14. 155th St Off-ramp	Off Ramp	26.3	0.81	19.4	0.46
15. 155th St Off-ramp to On-ramp	Basic	24.3	0.80	14.4	0.44

Level of Service: **A B C D E F**

*V/C = volume-to-capacity ratio

Opening Year (2023) FREEVAL Models

As mentioned in the introduction of this report, *The I-49 Gateway* BUILD application requests funding for an additional lane along I-49 in both directions to relieve existing and forecasted capacity issues. To demonstrate the value of the proposed improvements, both No-Build and Build versions of the model were created for the 2023 Opening Year. Opening-year volumes were developed as described in **Section 2** to accommodate for the increase in traffic expected by 2023. Seed capacity adjustment factors remained consistent with the Existing year models of similar type (No-Build and Build) to provide an accurate comparison to those models. The No-Build scenario indicates what would be expected in the Opening Year (2023) if no I-49 improvements were implemented. Results from the No-Build models are similar to the Existing (2020) conditions model results but indicate poorer LOS, increased density, and higher V/C ratios. Detailed FREEVAL results can be found in **Table 5**.

For the Opening Year Build scenario, FREEVAL indicates that all segments are expected to operate at LOS D or better. Density and V/C ratios are also expected to improve to acceptable levels under the Build conditions. Detailed FREEVAL results can be found in **Table 5**.

Forecast Year (2045) FREEVAL Models

Volumes from the Opening Year (2023) build models were grown to Forecast Year (2045) volumes at the rates described in **Section 2** to determine the longevity of the additional lane improvements. Other parameters within the 2045 models remained consistent to the previous models for comparison purposes.

For the 2045 No-Build scenario, seed capacity adjustment factors remained consistent with the values used in the previous models. Results from the models trend similar to the Opening Year (2023) no-build condition model results but indicate even poorer LOS, increased density, and higher V/C ratios. Seventeen segments along I-49 are expected to operate at LOS E or worse when examining both peak hour periods. Detailed FREEVAL results can be found in **Table 6**.

Results from the 2045 Build models trend similar to the Opening Year (2023) Build condition results but indicate decreased LOS, increase density, and higher V/C ratios. However, operations remain acceptable; all segments are expected to operate at LOS D or better. Detailed results can be found in **Table 6**.

Table 5. Opening Year (2023) FREEVAL Results – I-49 Mainline

Description	Type	No-Build				Build			
		AM Peak Period		PM Peak Period		AM Peak Period		PM Peak Period	
		Density (veh/mi/ln)	V/C	Density (veh/mi/ln)	V/C	Density (veh/mi/ln)	V/C	Density (veh/mi/ln)	V/C
Southbound									
1. 155th St Off-ramp to On-ramp	Basic	9.8	0.44	55.6	0.87	9.8	0.32	21.8	0.66
2. 155th St On-ramp	On Ramp	9.0	0.50	41.3	1.00	9.0	0.33	20.2	0.68
3. North of 163rd St 3-2 Transition	Basic	10.1	0.49	44.4	1.00	10.1	0.33	22.4	0.68
4. North of 163rd St	Basic	15.1	0.48	50.4	0.95	10.1	0.32	22.4	0.67
5. 163rd St Off-ramp	Off Ramp	14.5	0.50	34.2	1.00	10.9	0.33	24.0	0.69
6. 163rd St Off-ramp to On-ramp	Basic	10.4	0.42	27.8	0.88	6.9	0.28	16.3	0.62
7. 163rd St On-ramp	On Ramp	10.6	0.39	24.9	0.82	6.5	0.26	16.7	0.59
8. North of MO-58	Basic	10.8	0.35	24.9	0.74	7.2	0.23	16.6	0.53
9. MO-58 Off-ramp	Off Ramp	0.0	0.40	15.9	0.84	2.3	0.27	11.8	0.61
10. MO-58 Off-ramp to On-ramp	Basic	6.5	0.25	13.8	0.56	4.3	0.17	9.4	0.41
11. MO-58 On-ramp	On Ramp	8.8	0.25	18.0	0.55	6.1	0.16	12.6	0.39
12. North of N Cass Pkwy	Basic	7.5	0.25	16.1	0.55	5.0	0.16	11.0	0.39
13. N Cass Pkwy Off-ramp	Off Ramp	7.2	0.27	17.5	0.61	4.9	0.18	12.5	0.43
14. N Cass Pkwy Off- to On-ramp	Basic	7.1	0.24	14.5	0.51	4.7	0.16	9.9	0.36
15. N Cass Pkwy On-ramp	On Ramp	8.5	0.36	17.2	0.72	5.4	0.24	11.2	0.51
16. South of N Cass Pkwy	Basic	8.0	0.28	16.0	0.56	5.3	0.19	11.0	0.40
Northbound									
1. South of N Cass Pkwy	Basic	16.6	0.61	11.7	0.41	11.0	0.40	7.8	0.27
2. N Cass Pkwy Off-ramp	Off Ramp	16.9	0.64	11.2	0.43	11.3	0.43	7.7	0.29
3. N Cass Pkwy Off- to On-Ramp	Basic	15.6	0.60	10.2	0.37	10.3	0.40	6.8	0.25
4. N Cass Pkwy On-ramp	On Ramp	18.8	0.65	12.2	0.38	12.2	0.43	7.9	0.25
5. North of N Cass Pkwy	Basic	18.0	0.61	11.6	0.36	11.8	0.42	7.7	0.24
6. MO58 Off-ramp	Off Ramp	32.7	0.58	10.3	0.35	11.8	0.40	7.1	0.23
7. MO-58 Off-ramp to On-ramp	Basic	38.6	0.58	9.5	0.32	10.3	0.40	6.3	0.21
8. MO-58 On-ramp	On Ramp	32.7	1.00	17.5	0.66	20.7	0.76	13.5	0.44
9. North of MO-58	Basic	37.9	0.90	17.1	0.59	18.8	0.76	11.3	0.44
10. 163rd St Off-ramp	Off Ramp	37.2	0.92	16.6	0.60	18.0	0.68	11.4	0.39
11. 163rd St Off-ramp to On-ramp	Basic	42.7	0.88	15.3	0.56	16.8	0.67	10.2	0.37
12. 163rd St On-ramp	On Ramp	35.3	1.00	23.2	0.67	25.0	0.74	16.9	0.45
13. North of 163rd St	Basic	39.9	0.98	22.7	0.66	23.4	0.74	15.1	0.45
14. 155th St Off-ramp	Off Ramp	26.9	0.82	19.2	0.55	26.8	0.73	19.2	0.44
15. 155th St Off-ramp to On-ramp	Basic	25.1	0.80	14.4	0.53	22.7	0.73	14.4	0.43

Level of Service: **A B C D E F**

*V/C = volume-to-capacity ratio

Table 6. Future Year (2045) FREEVAL Results – I-49 Mainline

Description	Type	No-Build				Build			
		AM Peak Period		PM Peak Period		AM Peak Period		PM Peak Period	
		Density (veh/mi/ln)	V/C	Density (veh/mi/ln)	V/C	Density (veh/mi/ln)	V/C	Density (veh/mi/ln)	V/C
Southbound									
1. 155th St Off-ramp to On-ramp	Basic	12.2	0.56	74.2	0.83	12.1	0.40	27.8	0.84
2. 155th St On-ramp	On Ramp	11.2	0.63	64.4	0.93	11.2	0.42	25.4	0.86
3. North of 163rd St 3-2 Transition	Basic	12.8	0.62	63.7	0.93	12.5	0.42	28.8	0.86
4. North of 163rd St	Basic	18.8	0.61	62.2	0.91	12.5	0.41	28.5	0.84
5. 163rd St Off-ramp	Off Ramp	18.4	0.63	34.5	1.00	13.7	0.42	29.0	0.87
6. 163rd St Off-ramp to On-ramp	Basic	13.1	0.53	26.5	0.96	8.7	0.35	21.5	0.78
7. 163rd St On-ramp	On Ramp	13.4	0.50	24.5	0.87	8.3	0.33	21.7	0.72
8. North of MO-58	Basic	13.5	0.45	24.5	0.78	9.0	0.30	20.8	0.65
9. MO-58 Off-ramp	Off Ramp	3.2	0.51	15.5	0.90	0.1	0.34	17.7	0.74
10. MO-58 Off-ramp to On-ramp	Basic	8.1	0.32	12.4	0.77	5.4	0.21	11.8	0.49
11. MO-58 On-ramp	On Ramp	10.8	0.30	16.9	0.71	7.4	0.20	15.5	0.47
12. North of N Cass Pkwy	Basic	9.4	0.30	15.3	0.71	6.3	0.20	13.8	0.47
13. N Cass Pkwy Off-ramp	Off Ramp	9.4	0.33	16.4	0.78	6.5	0.22	15.8	0.52
14. N Cass Pkwy Off- to On-ramp	Basic	8.8	0.30	13.2	0.72	5.9	0.20	12.3	0.44
15. N Cass Pkwy On-ramp	On Ramp	10.7	0.45	16.2	0.93	6.9	0.30	14.1	0.61
16. South of N Cass Pkwy	Basic	10.1	0.35	15.4	0.73	6.7	0.23	13.7	0.48
Northbound									
1. South of N Cass Pkwy	Basic	77.0	0.71	15.2	0.52	13.7	0.51	10.1	0.35
2. N Cass Pkwy Off-ramp	Off Ramp	66.1	0.75	15.3	0.55	14.4	0.54	10.6	0.37
3. N Cass Pkwy Off- to On-Ramp	Basic	78.2	0.71	13.1	0.47	12.7	0.51	8.7	0.31
4. N Cass Pkwy On-ramp	On Ramp	79.8	0.76	16.0	0.52	15.4	0.55	10.5	0.35
5. North of N Cass Pkwy	Basic	93.4	0.74	15.2	0.50	14.8	0.53	10.1	0.33
6. MO58 Off-ramp	Off Ramp	103.8	0.68	14.6	0.48	15.2	0.51	10.0	0.32
7. MO-58 Off-ramp to On-ramp	Basic	112.5	0.60	12.6	0.45	12.9	0.51	8.4	0.30
8. MO-58 On-ramp	On Ramp	38.2	1.00	22.5	0.85	25.7	0.96	17.0	0.57
9. North of MO-58	Basic	40.1	0.83	23.2	0.77	26.4	0.96	14.7	0.57
10. 163rd St Off-ramp	Off Ramp	38.3	0.85	22.1	0.78	22.2	0.87	14.9	0.51
11. 163rd St Off-ramp to On-ramp	Basic	40.2	0.85	20.7	0.72	22.0	0.85	13.2	0.47
12. 163rd St On-ramp	On Ramp	36.1	1.00	29.3	0.85	30.6	0.94	21.2	0.57
13. North of 163rd St	Basic	41.8	0.98	29.8	0.84	30.3	0.94	19.2	0.57
14. 155th St Off-ramp	Off Ramp	27.4	0.82	23.2	0.70	31.5	0.92	23.2	0.56
15. 155th St Off-ramp to On-ramp	Basic	26.2	0.80	19.0	0.68	29.6	0.92	18.5	0.55

FREEVAL Results Summary

Table 7 includes “roll-up” metrics that characterize the overall performance of the 2045 FREEVAL models. The most compelling comparisons are found between the northbound AM and southbound PM models. In general, northbound traffic is expected to experience an overall reduction in travel time by approximately 12 minutes (over the 6.0-mile study area) while southbound traffic is expected to experience a reduction in travel time by roughly 2 minutes.

Table 7. FREEVAL Results Summary (Forecast Year 2045)

Measure	Northbound						Southbound					
	AM			PM			AM			PM		
	No-Build	Build	Δ	No-Build	Build	Δ	No-Build	Build	Δ	No-Build	Build	Δ
Length (mi)	6	6	0	6	6	0	6	6	0	6	6	0
Avg Travel Time (min)	17	6	11	6	6	0	5	5	0	7	5	2
VMT (veh-mi / intvl)	64,665	64,665	0	43,445	43,445	0	27,102	27,102	0	60,758	80,168	-19,410
VMTV (veh-m / intvl)	56,875	64,646	-7,771	43,427	43,427	0	27,098	27,098	0	61,130	80,162	-19,032
PMTD (p-mi / intvl)	64,665	64,665	0	43,445	43,445	0	27,102	27,102	0	60,758	80,168	-19,410
PMTV (p-mi / intvl)	56,875	64,646	-7,771	43,427	43,427	0	27,098	27,098	0	61,130	80,162	-19,032
VHT (per intvl (hrs))	2,371	1,034	1,337	690	670	20	428	422	6	1474	1276	198
VHD (per intvl (hrs))	8,274	66	8,208	40	20	21	20	13	6	3762	67	3695
Space Mean Speed (mph)	24	63	-39	63	65	-2	63	64	-1	41	63	-21
Reported Density (pc/mi/ln)	64	20	45	18	13	5	12	8	3	31	19	12
Max D/C	1.00	1.00	0	1.00	1.00	0	1.00	1.00	0	1.00	1.00	0
Max V/C	1.00	1.00	0	1.00	1.00	0	1.00	1.00	0	1.00	1.00	0

4. INTERSECTION (SYNCHRO) ANALYSIS

If interchange ramp terminals are congested, spillback queues can impact freeway operations and capacity along the freeway mainline. To verify whether this would be the case, the study team analyzed the signalized ramp terminals at Route Y (163rd Street), Route 58 (171st Street), and N Cass Parkway. Because the FREEVAL software does not include an intersection module, the study team used Synchro (Version 10.1, Build 2, Revision 20) to analyze operations at the ramp terminals. Synchro is a traffic engineering software that utilizes methodologies based on those published in the HCM (6th Edition) to calculate intersection delay, level of service (LOS), anticipated queue lengths, and other operational metrics that motorists could typically encounter while driving through the intersections. Results obtained from the Synchro models were used to determine if capacity adjustment factors within the FREEVAL models needed further modifications to account for off-ramp queuing.

Existing Conditions

Existing conditions Synchro models were developed for the 2020 AM and PM peak-periods for the at-grade ramp terminal intersections. Signal timing was unavailable for the two signalized intersections at the N. Cass Parkway interchange, so reasonable “Free Operation” signal timings (informed by

existing traffic volumes) were developed and input into the models. Balanced 2020 traffic volumes were used in the Synchro models. Results are shown in **Table 8**.

During the AM peak hour, all of the study ramps currently operate at acceptable levels of service (LOS C or better) with the exception of the northbound ramp at 163rd, which operates at LOS D. During the PM peak hour, all of the study ramps currently operate at acceptable levels of service (LOS C or better) with the exception of the southbound ramp at Route 58, which operates at LOS D.

During the AM peak hour, ramp queues exceed available storage at southbound ramp at 163rd in the right-turn lane, which queues into excess left-turn storage and does not queue onto the freeway. During the PM peak hour, ramp queues exceed available storage at southbound ramp at 163rd in the right-turn lane, which again queues into excess left-turn storage and does not queue onto the freeway.

Opening Year (2023)

Using the geometry and traffic control coded into the 2020 Existing Conditions Synchro models, plus the projected 2023 turning-movement volumes, the study team developed 2023 Opening Year AM and PM Peak Scenario Synchro models. Since no improvements to at-grade roadways or freeway ramps are included in the proposed I-49 Gateway, the Build and No-Build Synchro models were identical. Signal timings in each peak were optimized prior to extracting final operational results. Results are shown in **Table 8**.

In the 2023 Opening Year models, during the AM and PM peak hours, all of the study ramps operate at acceptable levels of service (LOS C or better). This is an overall improvement in comparison to the 2020 existing conditions due to traffic signal timing being optimized for the projected 2023 traffic volumes.

Results show that queues are anticipated to exceed available storage in the Northbound left and Southbound right-turn lanes at 163rd during the AM Peak and in the southbound left-turn lane at Route 58 and the southbound right-turn lane at 163rd during the PM Peak. The overall length of all of these ramps prevent these long queues from queuing onto the I-49 or affecting capacity of the I-49 through lanes.

Forecast Year (2045)

Synchro models were also developed for the 2045 Forecast Year, using the same geometry and traffic control modeled in the Existing and 2023 models, but with the forecasted 2045 turning movement volumes. Signal timings in each model were optimized prior to extracting final operational results.

During HDR's Route 58 Traffic Relief analysis for the City of Belton, the I-49/MO Route 58 interchange was modeled as a converted Single Point Urban Interchange (SPUI) in the 2040 forecast year. The results showed acceptable long-term levels-of-service (LOS) for this configuration, underscoring the importance of improvements to this interchange prior to 2040. For the purposes of the I-49 Gateway project, the study team assumed that such improvements would be completed prior to 2040; therefore, the long queues being reported on the southbound off-ramp in the 2045 Synchro models would not actually be experienced. Results are shown in **Table 8**.

In the 2045 Forecast Year models, during the AM and PM peak hours, all of the study ramps operate at acceptable levels of service (LOS C or better) with the exception of the Southbound ramp at 163rd, which operates at LOS D.

The movements / ramps with queues exceeding available queue storage in the 2023 Opening Year remain with poorer results in 2045. Again, the overall length of all of these ramps prevent these long queues from queuing onto the I-49 or affecting capacity of the I-49 through lanes.

Synchro Results Summary

Under existing conditions, a significant right-turn queue forms during the PM peak hour at the I-49 southbound off-ramp at 163rd Street. This queue is projected to worsen in 2045; however, it is not expected to spill off the ramp or impact speeds and free flow conditions on Interstate 49. The I-49 southbound off-ramp at Route 58 is also forecasted to experience a long queue during PM peak hours in the 2023 and 2045 Build models. With interchange improvements anticipated before 2045 and some signal optimization, the queues can be shortened and contained on the ramp without impacts to Interstate 49. Overall, the results of the Synchro analyses shows that existing and forecasted queues on ramps in 2020, 2023, and 2045 are not significant enough to warrant the need for capacity adjustments in the FREEVAL models.

Table 8. Synchro Results Summary

ID	Intersection	2020			2023			2045		
		95 th % Queue (ft)	Int Delay	Int LOS	95 th % Queue (ft)	Int Delay	Int LOS	95 th % Queue (ft)	Int Delay	Int LOS
AM Peak Hour										
2	I-49 NB Ramp / MO-58	NBL: 202 NBR: 62	13.3	B	NBL:131 NBR: 61	10.1	B	NBL: 197 NBR: 135	16.9	B
3	I-49 SB Ramp / MO-58	SBL: 175 SBR: 50	13.5	B	SBL: 128 SBR: 44	9.6	A	SBL: 188 SBR: 81	12.6	B
30	I-49 SB Ramp / N. Cass Pkwy	SBL: 16 SBR: 0	18.3	B	SBL: 17 SBR: 0	6.8	A	SBL: 23 SBR: 0	8.0	A
33	I-49 NB Ramp / N. Cass Pkwy	NBL: 43 NBR: 19	12.8	B	NBL: 46 NBR: 17	6.7	A	NBL: 67 NBR: 37	7.5	A
65	I-49 NB Ramp / 163rd St	NBL: 173 NBR: 28	47.7	D	NBL: #186 NBR: 25	25.9	C	NBL: #221 NBR:29	30.4	C
68	I-49 SB Ramp / 163rd St	SBL: 111 SBR: #176	15.9	B	SBL: 104 SBR: #174	16.3	B	SBL:125 SBR:#240	18.9	B
PM Peak Hour										
2	I-49 NB Ramp / MO-58	NBL: 205 NBR: 148	10.3	B	NBL:165 NBR:110	7.9	A	NBL: 217 NBR: 159	10.1	B
3	I-49 SB Ramp / MO-58	SBL: 533 SBR: 181	42.9	D	SBL: #528 SBR: 161	31.9	C	SBL: #738 * SBR: 239	56.2	E*
30	I-49 SB Ramp / N. Cass Pkwy	SBL: 37 SBR: 13	14.0	B	SBL: 39 SBR: 11	7.4	A	SBL: 63 SBR: 37	8.9	A
33	I-49 NB Ramp / N. Cass Pkwy	NBL: 38 NBR: 30	13.6	B	NBL: 41 NBR: 30	8.0	A	NBL: 66 NBR: 47	6.3	A
65	I-49 NB Ramp / 163rd St	NBL: 141 NBR: 0	13.9	B	NBL: 130 NBR: 0	14.1	B	NBL: 160 NBR: 12	16.8	B
68	I-49 SB Ramp / 163rd St	SBL: 149 SBR: #535	28.6	C	SBL: 123 SBR: #496	29.2	C	SBL: 150 SBR: #696	41.4	D

95th percentile volume exceeds capacity. Queue may be longer.

* Congestion issues at I-49/MO-58 anticipated to be resolved by interchange reconstruction prior to 2040

5. PREDICTIVE SAFETY ANALYSIS

Safety Analysis Approach

The safety analysis was conducted to understand existing safety conditions along the corridor and estimate future No-build and Build conditions crashes by severity.

The existing conditions safety analysis considers existing crashes by severity, crash rate and potential for safety improvement. Existing and future safety performance was also estimated using the Enhanced Interchange Safety Analysis (ISATe) tool. ISATe applies the AASHTO's Highway Safety Manual (HSM) freeway predictive method. As with the operational analyses, the assumed opening year for the analysis is 2023 and the future design year is 2045. For the future models, as discussed in more detail later, a representative segment was used, and the results were inflated.

Modelling Approach

The ISATe model was developed for I-49 freeway segments only, as the proposed improvements will not have any impact on the ramp segments or their terminals. Local calibration factors and severity distribution factors for the freeway were obtained from the Missouri Highway Safety Manual Recalibration Report. **Table 9** shows the calibration factors used in the ISATe model.

Table 9. Calibration Factors for the ISATe models

Type of Freeway Segment	Fatal and Injury Crashes		Property Damage Crashes	
	Multi-Vehicle	Single-Vehicle	Multi-Vehicle	Single-Vehicle
Urban Four-Lane	0.708	0.603	1.461	1.2
Urban Six-Lane	0.846	0.964	1.22	0.854

Source: <https://spexternal.modot.mo.gov/sites/cm/CORDT/cmr18-001.pdf>

The severity distribution factors (SDFs) from the MoDOT Highway Safety Manual Recalibration research report were applied to the multi-vehicle and single-vehicle crashes estimated in the ISATe model (**Table 10**).

Table 10. Severity Distribution Factors (SDFs) – Freeway Segments

Crash Severity Type	Four-Lane		Six-Lane	
	Multi-Vehicle	Single-Vehicle	Multi-Vehicle	Single-Vehicle
Fatal	0.009	0.011	0.002	0.014
Disabling Injury	0.030	0.032	0.018	0.036
Minor Injury	0.177	0.136	0.222	0.248
PDO	0.784	0.82	0.757	0.701
Total	1.000	1.000	1.000	1.000

Source: <https://spexternal.modot.mo.gov/sites/cm/CORDT/cmr18-001.pdf>

The representative I-49 sub-segment modelled in ISATe was between 163rd Street (Route Y) and MO Route 58 (gore-to-gore, 0.77 miles). The geometric cross-sectional features and traffic volume of this sub-section are typical throughout the study corridor; thus, it is reasonable to extrapolate the safety impact to the whole study corridor. The predicted ISATe crashes within the sub-segment were therefore factored up to represent the 4.21-mile study corridor. ISATe models for the typical sub-segment were developed for Existing, No-Build, and Build conditions.

Existing Conditions Safety Analysis

A. Crash Frequency, Severity and Type

The most recent crash data from 2014-2018 was obtained from MoDOT for the segment of I-49 from approximately 0.2 miles south of MO-150 to 0.4 miles north of CRD 195th Street for a total distance of approximately 5.82 miles. **Table 11** shows the existing conditions crashes for the study corridor.

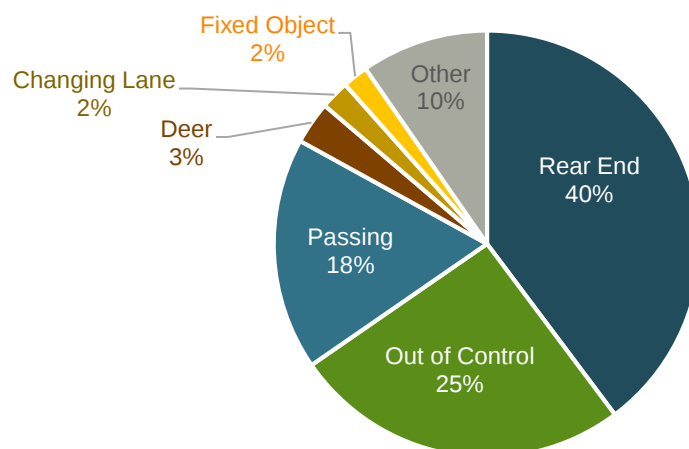
Table 11. Summary of Crashes from 2014-2018
I-49 (5.82 miles)

Crash Severity Type	Number of Crashes	
	Total Crashes	Crashes per Year
Fatal	4	0.8
Disabling Injury	16	3.2
Minor Injury	195	39.0
PDO	562	112.4
Total	777	155.4

Source: Missouri Department of Transportation (MoDOT)

Figure 4 presents the crash type severity distribution for existing crashes (2014-2018) for the full corridor. The top three crash types were rear-end (40-percent), out-of-control, and passing. Out-of-control and passing crashes are not uncommon on high-speed interstate facilities, but rear-end crashes are not – unless congestion is present. There is strong reason to believe these rear-end crashes are tied to congestion on the facility.

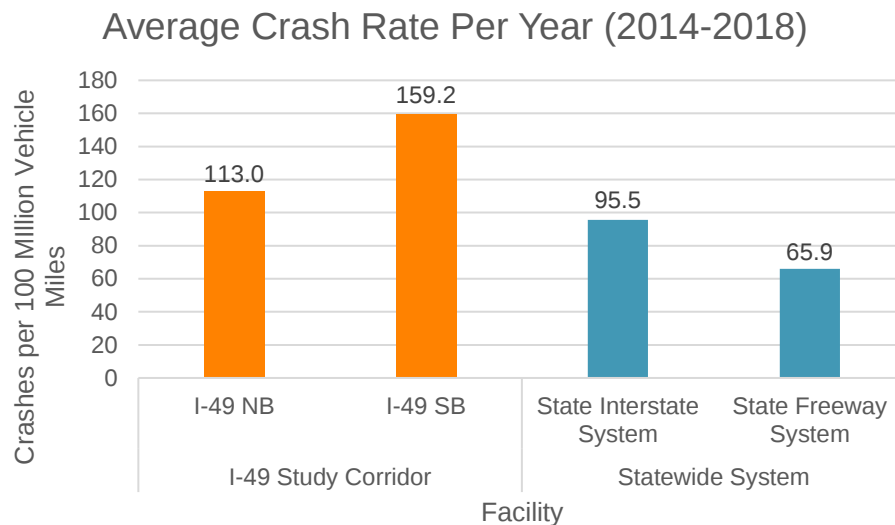
Figure 4. Percentage of Crash Types on I-49 Study Corridor



B. Crash Rate

The study team compared MoDOT's published statewide average crash rates for 2014-2018 with the northbound and southbound I-49 study corridor segment crash rates over the same period, as shown in **Figure 5**. The average crash rates for the northbound and southbound direction of the study corridor were higher than the statewide average rates.

Figure 5. 2014-2018 Average Crash Rates for I-49, State Interstate and Freeway System



C. Potential for Safety Improvement

The measure known as Potential for Safety Improvement (PSI) uses the AASHTO HSM Predictive Method to identify the potential for crash reductions by comparing two ways of estimating existing crash frequencies:

- Predicted average crash frequency is based on Safety Performance Functions from the HSM and is not influenced by historical crashes within the corridor. It essentially measures how many crashes would be predicted on a facility of a given type and length with a certain set of characteristics (such as traffic volumes, lane widths, etc.).
- Expected average crash frequency factors in observed crash history and weights the observed and predicted crashes to determine how many annual crashes would be expected on this particular corridor.

The PSI is calculated as the existing expected average crash frequency minus the existing predicted average crash frequency. (very broadly, the difference between crash trends that are actually happening on the corridor and crash trends that happen on similar corridors.) If the outcome is positive, there is potential for safety improvement. As shown in **Table 12**, the existing expected average crash frequency exceeds the existing predicted average crash frequency, and thus the corridor shows potential for safety improvement.

Table 12. ISATe Existing Expected and Predicted Crashes

Existing Scenarios	HSM Avg Crashes 2014-2018
Existing Expected Average	94.0
Predicted Average	58.6
Potential for Safety Improvement	35.4

Opening Year and Design Year Safety Performance

As described above, the ISATe HSM model was developed for the typical sub-section between 163rd Street and MO Route 58, and the predicted ISATe crashes were factored to the entire study corridor.

Note that the proposed study corridor has a median barrier in its northern portion (north of 163rd Street) for approximately 2.73 miles; the remaining corridor from 163rd Street to North Cass Parkway (1.48 miles) does not have a median barrier. Thus, separate ISATe models were developed: one typical section with a median barrier and one without. The final results from the future ISATe models are provided in **Table 13**. As the table shows, the proposed lane addition would reduce total crashes by 33 to 35 percent within the corridor (which is almost the same percentage as the number of rear-end crashes currently occurring on the corridor).

Table 13. ISATe HSM Predicted crashes for Opening Year (2023) and Design year (2045)

Severity	Opening Year - 2023			Design Year - 2045		
	No-Build	Build	% change	No-Build	Build	% change
Fatal	0.7	0.3	-57%	1.0	0.4	-60%
Disabling Injury	2.2	1.2	-45%	3.1	1.6	-48%
Minor Injury	11.5	11.0	-4%	16.9	15.1	-11%
PDO	56.2	34.6	-38%	80.7	48.4	-40%
Total	70.5	47.1	-33%	101.7	65.5	-35%

6. SUMMARY OF RESULTS AND CONCLUSIONS

Freeway (FREEVAL) analysis indicates that operations are expected to deteriorate significantly in the future. Build analysis shows that adding capacity in each direction would reduce delay and congestion along the corridor. In general, northbound traffic is expected to experience an overall reduction in travel time by approximately 12 minutes (over the 6.0-mile study area) while southbound traffic is expected to experience a reduction in travel time by roughly 2 minutes.

Mesoscopic analysis (using Synchro) of the freeway ramps and interchange terminals projected growing queues along the ramps, but these are not expected to influence traffic along the I-49 corridor. Overall, the results of the Synchro analyses show that existing and forecasted queues on ramps in 2020, 2023, and 2045 are not significant enough to warrant the need for capacity adjustments in the FREEVAL models.

Predicted crash information was analyzed using ISATe; it was determined that the proposed lane addition would reduce total expected crashes by 33 to 35 percent within the corridor (which is almost the same percentage as the number of rear-end crashes currently occurring on the corridor).

1. References

1. AASHTO's Highway Safety Manual (2012).

Link: <http://www.highwaysafetymanual.org/Pages/default.aspx>

2. Sun, C., Edara, P., Brown, H., Berry, J., Claros, B., and Yu, X., 2018. Missouri Highway Safety Manual Recalibration.

Link: <https://spexternal.modot.mo.gov/sites/cm/CORDT/cmr18-001.pdf>

ATTACHMENT E1: FREEVAL INPUT

Attachment E-1 – FREEVAL Inputs

FREEVAL Input – 2017 Hourly

Segment Name	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	I-49/US-71/155th Street Interchange	I-49/US-71/155th Street OFR	I-49/US-71 North of 163rd Street 3-2 Transition	I-49/US-71 North of 163rd Street	I-49/US-71/163rd Street OFR	I-49/US-71/163rd Street Interchange	I-49/US-71/163rd Street ONR	I-49/US-71 North of MO58	I-49/US-71/MO58 OFR	I-49/US-71/MO-58 Interchange	I-49/US-71/MO58 ONR	I-49/US-71 North of N Cass Parkway	I-49/US-71/N Cass Parkway OFR	I-49/US-71/N Cass Parkway Interchange	I-49/US-71/N Cass Parkway ONR	I-49/US-71/South of N Cass Parkway
TMS ID					019-010154-3		019-010295-3		019-010155-3		019-009733-2	019-000177-3	019-000589-3		019-000590-3	
Segment Type	Basic	On_R	Basic	Basic	Off_R	Basic	On_R	Basic	Off_R	Basic	On_R	Basic	Off_R	Basic	On_R	Basic
00:00:00	401	16	417	417	109	308	14	322	125	197	23	220	14	206	10	216
01:00:00	314	13	327	327	81	262	16	262	98	164	18	182	2	180	6	186
02:00:00	219	11	230	230	49	181	18	199	44	155	14	169	7	162	2	164
03:00:00	262	13	275	275	73	202	17	219	58	161	14	175	3	172	4	176
04:00:00	318	18	336	336	81	206	255	278	72	206	26	232	6	226	13	239
05:00:00	594	20	614	614	143	471	34	505	157	348	48	396	13	383	28	411
06:00:00	1265	30	1295	1295	369	926	77	1003	292	711	113	824	38	786	76	862
07:00:00	1740	45	1785	1785	577	1208	98	1306	532	774	171	945	49	896	168	1064
08:00:00	1821	58	1879	1879	607	1272	116	1388	611	707	152	929	55	874	83	957
09:00:00	1892	64	1956	1956	591	1365	107	1472	582	890	163	1053	56	997	62	1059
10:00:00	1939	74	2013	2013	564	1449	107	1556	650	906	200	1106	49	1057	61	1118
11:00:00	2083	83	2166	2166	684	1482	137	1619	739	880	245	1125	76	1049	88	1137
12:00:00	2219	86	2305	2305	698	1607	146	1753	855	898	284	1182	74	1108	93	1201
13:00:00	2339	88	2427	2427	739	1688	169	1857	853	1004	298	1302	84	1218	103	1321
14:00:00	2750	92	2842	2842	869	1973	161	2134	976	1158	324	1482	86	1396	124	1520
15:00:00	3776	98	3874	3874	1075	2799	177	2976	1215	1761	328	2089	153	1936	161	2097
16:00:00	3799	106	3905	3905	1060	2845	239	3084	1211	1873	391	2264	198	2066	179	2245
17:00:00	3778	105	3883	3883	1106	2777	240	3017	1375	1642	377	2019	245	1774	203	1977
18:00:00	2932	94	3026	3026	844	2182	152	2334	1079	1255	311	1566	151	1415	129	1544
19:00:00	1950	73	2023	2023	677	1346	142	1488	719	769	264	1033	100	933	106	1039
20:00:00	1502	59	1561	1561	532	1029	126	1155	539	616	190	806	73	733	67	800
21:00:00	1165	48	1213	1213	379	834	53	887	431	456	127	583	59	524	36	560
22:00:00	821	38	859	859	276	583	38	633	264	369	71	440	30	410	34	444
23:00:00	601	29	630	630	188	442	17	459	175	284	46	330	19	311	16	327
	Peak Hour Volume Counts Count from 2019															
Segment Name	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
	I-49/US-71/South of N Cass Parkway	I-49/US-71/N Cass Parkway OFR	I-49/US-71/N Cass Parkway Interchange	I-49/US-71/N Cass Parkway ONR	I-49/US-71 North of N Cass Parkway	I-49/US-71/MO58 OFR	I-49/US-71/MO-58 Interchange	I-49/US-71/MO58 ONR	I-49/US-71 North of MO58	I-49/US-71/163rd Street OFR	I-49/US-71/163rd Street Interchange	I-49/US-71/163rd Street ONR	I-49/US-71 North of 163rd Street	I-49/US-71/155th Street OFR	I-49/US-71/155th Street Interchange	
TMS ID		019-000591-1		019-000592-1	019-000177-1	019-000882-1		019-009732-4		019-009790-2		019-010398-2				
Segment Type	Basic	Off_R	Basic	On_R	Basic	Off_R	Basic	On_R	Basic	Off_R	Basic	On_R	Basic	Off_R	Basic	
00:00:00	169	9	160	3	163	23	140	91	231	18	213	54	267	17	250	
01:00:00	101	9	92	6	98	12	86	57	143	10	133	46	179	13	166	
02:00:00	121	5	116	8	124	11	113	45	158	10	148	41	189	12	177	
03:00:00	160	9	151	10	161	14	147	69	216	40	176	61	237	14	223	
04:00:00	378	6	372	19	391	38	353	177	530	31	499	152	651	20	631	
05:00:00	1167	18	1149	87	1236	90	1146	582	1728	66	1662	455	2117	39	2078	
06:00:00	2122	71	2051	264	2315	202	2113	1203	3316	122	3194	986	4180	65	4115	
07:00:00	1957	126	1831	279	2110	264	1846	1319	3165	155	3010	986	3996	77	3919	
08:00:00	1571	118	1453	210	1663	254	1409	1086	2495	153	2342	869	3211	76	3135	
09:00:00	1296	88	1208	104	1312	219	1093	809	1902	219	1683	647	2330	83	2247	
10:00:00	1228	101	1127	78	1205	222	983	737	1720	123	1597	609	2206	90	2116	
11:00:00	1228	101	1127	69	1196	236	960	768	1728	110	1618	608	2226	94	2132	
12:00:00	1248	113	1135	71	1206	263	943	809	1752	136	1616	674	2290	96	2194	
13:00:00	1186	92	1094	73	1167	212	955	786	1741	134	1607	694	2301	98	2203	
14:00:00	1358	141	1217	67	1284	217	1067	797	1864	113	1751	648	2399	101	2298	
15:00:00	1414	160	1254	79	1333	238	1095	778	1873	148	1725	795	2520	104	2416	
16:00:00	1437	184	1253	108	1361	225	1136	812	1948	183	1765	770	2535	104	2431	
17:00:00	1431	201	1230	105	1335	263	1072	842	1914	226	1688	731	2419	95	2324	
18:00:00	1030	120	910	75	985	231	754	697	1451	1308	635	1943	76	1867		
19:00:00	764	70	694	51	745	143	602	569	1171	117	1054	511	1565	60	1505	
20:00:00	677	63	614	47	661	111	550	497	1047	91	956	419	1375	48	1327	
21:00:00	477	34	443	23	466	75	391	406	797	55	742	278	1020	39	981	
22:00:00	345	24	321	17	338	40	298	249	547	36	511	198	709	30	679	
23:00:00	269	15	254	10	264	41	223	143	366	21	345	79	424	23	401	
	Peak Hour Volume Counts Count from 2019															

Attachment E-1 – FREEVAL Inputs

FREEVAL Input – 2020 Hourly

Segment Name	1 I-49/US-71/155th Street Interchange	2 I-49/US-71/155th Street OFR	3 I-49/US-71 North of 163rd Street 3-2 Transition	4 I-49/US-71 North of 163rd Street	5 I-49/US-71/163rd Street OFR	6 I-49/US-71/163rd Street Interchange	7 I-49/US-71/163rd Street ONR	8 I-49/US-71 North of MO58	9 I-49/US-71/MO58 OFR	10 I-49/US-71/MO-58 Interchange	11 I-49/US-71/MO58 ONR	12 I-49/US-71 North of N Cass Parkway	13 I-49/US-71/N Cass Parkway OFR	14 I-49/US-71/N Cass Parkway Interchange	15 I-49/US-71/N Cass Parkway ONR	16 I-49/US-71/South of N Cass Parkway
TMS ID					019-010154-3		019-010295-3		019-010155-3		019-009733-2	019-000177-3	019-000589-3		019-000590-3	
Segment Type	Basic	On_R	Basic	Basic	Off_R	Basic	On_R	Basic	Off_R	Basic	On_R	Basic	Off_R	Basic	On_R	Basic
00:00:00	427	17	444	444	116	328	15	343	133	210	25	234	15	220	11	230
01:00:00	335	14	349	349	86	262	17	279	104	175	19	194	2	192	6	198
02:00:00	233	12	245	245	52	193	19	212	47	165	15	180	7	173	2	175
03:00:00	279	14	293	293	78	215	18	233	62	172	15	187	3	183	4	188
04:00:00	339	19	358	358	86	272	25	296	77	220	28	247	6	241	14	255
05:00:00	633	21	654	654	152	502	36	538	167	371	51	422	14	408	30	438
06:00:00	1348	32	1380	1380	393	987	82	1069	311	758	120	878	41	838	81	919
07:00:00	1855	59	1903	1903	615	1288	120	1408	567	841	184	1025	66	959	179	1138
08:00:00	1941	62	2003	2003	647	1356	124	1479	651	828	162	990	59	932	88	1020
09:00:00	2017	68	2085	2085	630	1455	114	1569	620	949	174	1122	60	1063	66	1129
10:00:00	2067	79	2146	2146	601	1544	114	1659	693	966	213	1179	52	1127	65	1192
11:00:00	2220	88	2309	2309	729	1580	146	1726	788	938	261	1199	81	1118	94	1212
12:00:00	2365	92	2457	2457	744	1713	156	1869	911	957	303	1260	79	1181	99	1280
13:00:00	2493	94	2587	2587	788	1799	180	1979	909	1070	318	1388	90	1298	110	1408
14:00:00	2931	98	3029	3029	926	2103	172	2275	1040	1234	345	1580	92	1488	132	1620
15:00:00	4025	104	4129	4129	1146	2983	189	3172	1295	1877	350	2227	163	2064	172	2235
16:00:00	4055	107	4162	4162	1130	3032	339	3371	1332	2039	417	2456	263	2193	256	2449
17:00:00	4027	112	4139	4139	1179	2960	256	3216	1466	1750	402	2152	261	1891	216	2107
18:00:00	3125	100	3225	3225	900	2326	162	2488	1150	1338	331	1669	161	1508	138	1646
19:00:00	2078	78	2156	2156	722	1435	151	1586	766	820	281	1101	107	994	113	1107
20:00:00	1601	63	1664	1664	567	1097	134	1231	575	657	203	859	78	781	71	853
21:00:00	1242	51	1293	1293	404	889	56	945	459	486	135	621	63	559	38	597
22:00:00	875	41	916	916	294	621	53	675	281	393	76	469	32	437	36	473
23:00:00	641	31	672	672	200	471	18	489	187	303	49	352	20	331	17	349

***Pulled From Traffic Volume Forecast Spreadsheet**
Peak Hour Volume Counts From Volume Forecast Spreadsheet
Based on count from 2019

Segment Name	1 I-49/US-71/South of N Cass Parkway	2 I-49/US-71/N Cass Parkway OFR	3 I-49/US-71/N Cass Parkway Interchange	4 I-49/US-71/N Cass Parkway ONR	5 I-49/US-71 North of N Cass Parkway	6 I-49/US-71/MO58 OFR	7 I-49/US-71/MO-58 Interchange	8 I-49/US-71/MO58 ONR	9 I-49/US-71 North of MO58	10 I-49/US-71/163rd Street OFR	11 I-49/US-71/163rd Street Interchange	12 I-49/US-71/163rd Street ONR	13 I-49/US-71 North of 163rd Street	14 I-49/US-71/155th Street OFR	15 I-49/US-71/155th Street Interchange	
TMS ID		019-000591-1		019-000592-1	019-000177-1	019-009882-1		019-009732-4		019-009790-2		019-010398-2				
Segment Type	Basic	Off_R	Basic	On_R	Basic	Off_R	Basic	On_R	Basic	Off_R	Basic	On_R	Basic	Off_R	Basic	
00:00:00	180	10	171	3	174	25	149	97	246	19	227	58	285	18	266	
01:00:00	108	10	98	6	104	13	92	61	152	11	142	49	191	14	177	
02:00:00	129	5	124	9	132	12	120	48	168	11	158	44	201	13	189	
03:00:00	171	10	161	11	172	15	157	74	230	43	188	65	253	15	238	
04:00:00	403	6	397	20	417	41	376	189	565	33	532	162	694	21	673	
05:00:00	1244	19	1225	93	1317	96	1222	620	1842	70	1772	485	2257	42	2215	
06:00:00	2262	76	2186	281	2468	215	2252	1282	3535	130	3404	1051	4455	69	4386	
07:00:00	2176	196	1980	353	2333	379	1954	1406	3360	372	2988	1272	4260	79	4181	
08:00:00	1675	126	1549	224	1773	271	1502	1158	2659	163	2496	926	3423	81	3342	
09:00:00	1381	94	1288	111	1398	233	1165	862	2027	233	1794	690	2484	88	2395	
10:00:00	1309	108	1201	83	1284	237	1048	786	1833	131	1702	649	2351	96	2255	
11:00:00	1309	108	1201	74	1275	252	1023	819	1842	117	1725	648	2373	100	2272	
12:00:00	1330	120	1210	76	1285	280	1005	862	1867	145	1722	718	2441	102	2339	
13:00:00	1264	98	1166	78	1244	226	1018	838	1856	143	1713	740	2453	104	2348	
14:00:00	1447	150	1297	71	1369	231	1137	850	1987	120	1866	691	2557	108	2449	
15:00:00	1507	171	1337	84	1421	254	1167	829	1996	158	1839	847	2686	111	2575	
16:00:00	1532	215	1317	342	1659	278	1381	866	2247	245	2002	821	2823	106	2717	
17:00:00	1525	214	1311	112	1423	280	1143	897	2040	241	1799	779	2578	101	2477	
18:00:00	1098	128	970	80	1050	246	804	743	1547	152	1394	677	2071	81	1990	
19:00:00	814	75	740	54	794	152	642	606	1248	125	1123	545	1668	64	1604	
20:00:00	722	67	654	50	705	118	586	530	1116	97	1019	447	1466	51	1414	
21:00:00	508	36	472	25	497	80	417	433	850	59	791	296	1087	42	1046	
22:00:00	368	26	342	18	360	43	318	265	583	38	545	211	756	32	724	
23:00:00	287	16	271	11	281	44	238	152	390	22	368	84	452	25	427	

***Pulled From Traffic Volume Forecast Spreadsheet**
Peak Hour Volume Counts From Volume Forecast Spreadsheet
Based on count from 2019

Attachment E-1 – FREEVAL Inputs

FREEVAL Input – 2023 Hourly

Segment Name	1 I-49/US-71/155th Street Interchange	2 I-49/US-71/155th Street OFR	3 I-49/US-71 North of 163rd Street 3-2 Transition	4 I-49/US-71 North of 163rd Street	5 I-49/US-71/163rd Street OFR	6 I-49/US-71/163rd Street Interchange	7 I-49/US-71/163rd Street ONR	8 I-49/US-71 North of MO58	9 I-49/US-71/MO58 OFR	10 I-49/US-71/MO-58 Interchange	11 I-49/US-71/MO58 ONR	12 I-49/US-71 North of N Cass Parkway	13 I-49/US-71/N Cass Parkway OFR	14 I-49/US-71/N Cass Parkway Interchange	15 I-49/US-71/N Cass Parkway ONR	16 I-49/US-71/South of N Cass Parkway
TMS ID					019-010154-3		019-010295-3		019-010155-3		019-009733-2	019-000177-3	019-000589-3		019-000590-3	
Segment Type	Basic	On_R	Basic	Basic	Off_R	Basic	On_R	Basic	Off_R	Basic	On_R	Basic	Off_R	Basic	On_R	Basic
00:00:00	442	18	459	459	120	339	15	355	138	217	25	242	15	227	11	238
01:00:00	346	14	360	360	89	271	18	288	108	181	20	200	2	198	7	205
02:00:00	241	12	253	253	54	199	20	219	48	171	15	186	8	178	2	181
03:00:00	288	14	303	303	80	222	19	241	64	177	15	193	3	189	4	194
04:00:00	350	20	370	370	89	281	25	306	79	227	29	255	7	249	14	263
05:00:00	654	22	676	676	157	519	37	556	173	383	53	436	14	422	31	453
06:00:00	1393	33	1426	1426	406	1020	85	1104	322	783	124	907	42	865	84	949
07:00:00	1887	60	1947	1947	621	1326	121	1447	583	864	189	1053	70	983	190	1173
08:00:00	2005	64	2069	2069	668	1401	128	1528	673	856	167	1023	61	962	91	1054
09:00:00	2083	70	2154	2154	651	1503	118	1621	641	980	179	1159	62	1098	68	1166
10:00:00	2135	81	2217	2217	621	1596	118	1713	716	998	220	1218	54	1164	67	1231
11:00:00	2294	91	2385	2385	753	1632	151	1783	814	969	270	1239	84	1155	97	1252
12:00:00	2443	95	2538	2538	769	1770	161	1930	941	989	313	1302	81	1220	102	1322
13:00:00	2576	97	2672	2672	814	1859	186	2045	939	1106	328	1434	92	1341	113	1455
14:00:00	3028	101	3129	3129	957	2173	177	2350	1075	1275	357	1632	95	1537	137	1674
15:00:00	4158	108	4266	4266	1184	3082	195	3277	1338	1939	361	2300	168	2132	177	2309
16:00:00	4144	109	4253	4253	1148	3105	345	3450	1356	2094	424	2518	281	2237	273	2510
17:00:00	4160	116	4276	4276	1218	3058	264	3322	1514	1808	415	2223	270	1953	224	2177
18:00:00	3229	104	3332	3332	929	2403	167	2570	1188	1382	342	1724	166	1558	142	1700
19:00:00	2147	80	2228	2228	745	1482	156	1638	792	847	291	1137	110	1027	117	1144
20:00:00	1654	65	1719	1719	586	1133	139	1272	594	678	209	888	80	807	74	881
21:00:00	1283	53	1336	1336	417	918	58	977	475	502	140	642	65	577	40	617
22:00:00	904	42	946	946	304	642	55	697	291	406	78	484	33	451	37	489
23:00:00	662	32	694	694	207	487	19	505	193	313	51	363	21	342	18	360

*Pulled From Traffic Volume Forecast Spreadsheet

Peak Hour Volume Counts From Volume Forecast Spreadsheet
Based on count from 2019

Segment Name	1 I-49/US-71/South of N Cass Parkway	2 I-49/US-71/N Cass Parkway OFR	3 I-49/US-71/N Cass Parkway Interchange	4 I-49/US-71/N Cass Parkway ONR	5 I-49/US-71 North of N Cass Parkway	6 I-49/US-71/MO58 OFR	7 I-49/US-71/MO-58 Interchange	8 I-49/US-71/MO58 ONR	9 I-49/US-71 North of MO58	10 I-49/US-71/163rd Street OFR	11 I-49/US-71/163rd Street Interchange	12 I-49/US-71/163rd Street ONR	13 I-49/US-71 North of 163rd Street	14 I-49/US-71/155th Street OFR	15 I-49/US-71/155th Street Interchange	
TMS ID		019-000591-1		019-000592-1	019-000177-1	019-009882-1		019-009732-4		019-009790-2		019-010398-2				
Segment Type	Basic	Off_R	Basic	On_R	Basic	Off_R	Basic	On_R	Basic	Off_R	Basic	On_R	Basic	Off_R	Basic	
00:00:00	186	10	176	3	179	25	154	100	254	20	235	59	294	19	275	
01:00:00	111	10	101	7	108	13	95	63	157	11	146	51	197	14	183	
02:00:00	133	6	128	9	137	12	124	50	174	11	163	45	208	13	195	
03:00:00	176	10	166	11	177	15	162	76	238	44	194	67	261	15	246	
04:00:00	416	7	410	21	431	42	389	195	584	34	549	167	717	22	695	
05:00:00	1285	20	1265	96	1361	99	1262	641	1903	73	1830	501	2331	43	2288	
06:00:00	2337	78	2258	291	2549	222	2327	1325	3651	134	3517	1086	4603	72	4531	
07:00:00	2231	208	2023	374	2397	390	2007	1446	3453	376	3077	1285	4362	80	4282	
08:00:00	1730	130	1600	231	1831	280	1551	1196	2747	168	2579	957	3536	84	3452	
09:00:00	1427	97	1330	115	1445	241	1204	891	2094	241	1853	712	2566	91	2474	
10:00:00	1352	111	1241	86	1327	244	1082	812	1894	135	1759	671	2429	99	2330	
11:00:00	1352	111	1241	76	1317	260	1057	846	1903	121	1782	669	2451	104	2348	
12:00:00	1374	124	1250	78	1328	290	1038	891	1929	151	1779	742	2522	106	2416	
13:00:00	1306	101	1205	80	1285	233	1052	865	1917	148	1770	764	2534	108	2426	
14:00:00	1495	155	1340	74	1414	239	1175	878	2053	124	1928	714	2642	111	2530	
15:00:00	1557	176	1381	87	1468	262	1206	857	2062	163	1899	875	2775	115	2660	
16:00:00	1566	230	1336	365	1701	283	1418	882	2300	249	2051	834	2885	108	2777	
17:00:00	1576	221	1354	116	1470	290	1180	927	2108	249	1859	805	2664	105	2559	
18:00:00	1134	132	1002	83	1085	254	830	767	1598	157	1440	699	2140	84	2056	
19:00:00	841	77	764	56	820	157	663	627	1289	129	1161	563	1723	66	1657	
20:00:00	745	69	676	52	728	122	606	547	1153	100	1053	461	1514	53	1461	
21:00:00	525	37	488	25	513	83	431	447	878	61	817	306	1123	43	1080	
22:00:00	380	26	353	19	372	44	328	274	602	40	563	218	781	33	748	
23:00:00	296	17	280	11	291	45	246	157	403	23	380	87	467	25	442	

*Pulled From Traffic Volume Forecast Spreadsheet

Peak Hour Volume Counts From Volume Forecast Spreadsheet
Based on count from 2019

Attachment E-1 – FREEVAL Inputs

FREEVAL Input – 2045 Hourly

Segment Name	1 I-49/US-71/155th Street Interchange	2 I-49/US-71/155th Street OFR	3 I-49/US-71 North of 163rd Street 3-2 Transition	4 I-49/US-71 North of 163rd Street	5 I-49/US-71/163rd Street OFR	6 I-49/US-71/163rd Street Interchange	7 I-49/US-71/163rd Street ONR	8 I-49/US-71 North of MO58	9 I-49/US-71/MO58 OFR	10 I-49/US-71/MO-58 Interchange	11 I-49/US-71/MO58 ONR	12 I-49/US-71 North of N Cass Parkway	13 I-49/US-71/N Cass Parkway OFR	14 I-49/US-71/N Cass Parkway Interchange	15 I-49/US-71/N Cass Parkway ONR	16 I-49/US-71/South of N Cass Parkway
TMS ID					019-010154-3		019-010295-3		019-010155-3		019-009733-2	019-000177-3	019-000589-3		019-000590-3	
Segment Type	Basic	On_R	Basic	Basic	Off_R	Basic	On_R	Basic	Off_R	Basic	On_R	Basic	Off_R	Basic	On_R	Basic
00:00:00	560	22	583	583	152	430	20	450	175	275	32	307	20	288	14	302
01:00:00	439	18	457	457	113	344	22	366	137	229	25	254	3	252	8	260
02:00:00	306	15	321	321	68	253	25	278	61	217	20	236	10	226	3	229
03:00:00	366	18	384	384	102	282	24	306	81	225	20	245	4	240	6	246
04:00:00	444	25	470	470	113	356	32	389	101	288	36	324	8	316	18	334
05:00:00	830	28	858	858	200	658	48	706	219	486	67	553	18	535	39	574
06:00:00	1768	42	1810	1810	516	1294	108	1402	408	994	158	1152	53	1099	106	1205
07:00:00	2238	65	2303	2303	668	1635	130	1765	715	1050	232	1282	107	1175	291	1466
08:00:00	2545	81	2626	2626	848	1778	162	1940	854	1086	212	1298	77	1222	116	1338
09:00:00	2644	89	2734	2734	826	1908	150	2057	813	1244	228	1472	78	1394	87	1480
10:00:00	2710	103	2814	2814	788	2025	150	2175	909	1266	205	1546	68	1477	85	1563
11:00:00	2911	116	3027	3027	956	2071	191	2263	1033	1230	342	1572	106	1466	123	1589
12:00:00	3102	120	3222	3222	976	2246	204	2450	1195	1255	397	1652	103	1549	130	1679
13:00:00	3269	123	3392	3392	1033	2359	236	2596	1192	1236	417	1820	117	1702	144	1846
14:00:00	3844	129	3972	3972	1215	2758	225	2983	1364	1619	453	2071	120	1951	173	2125
15:00:00	5278	137	5415	5415	1503	3912	247	4160	1698	2461	458	2920	214	2706	225	2931
16:00:00	4868	123	4991	4994	1292	3699	388	4087	1545	2542	483	3025	456	2569	443	3012
17:00:00	5281	147	5427	5427	1546	3881	335	4217	1922	2295	527	2822	342	2480	284	2763
18:00:00	4098	131	4229	4229	1180	3050	212	3262	1508	1754	435	2189	211	1978	180	2158
19:00:00	2726	102	2828	2828	946	1881	198	2080	1005	1075	369	1444	140	1304	148	1452
20:00:00	2099	82	2182	2182	744	1438	176	1614	753	861	266	1127	102	1025	94	1118
21:00:00	1628	67	1695	1695	530	1166	74	1240	602	637	178	815	82	732	50	783
22:00:00	1148	53	1201	1201	386	815	70	885	369	516	99	615	42	573	48	621
23:00:00	840	41	881	881	263	618	24	642	245	397	64	461	27	435	22	457

*Pulled From Traffic Volume Forecast Spreadsheet

Peak Hour Volume Counts From Volume Forecast Spreadsheet
Based on count from 2019

Segment Name	1 I-49/US-71/South of N Cass Parkway	2 I-49/US-71/N Cass Parkway OFR	3 I-49/US-71/N Cass Parkway Interchange	4 I-49/US-71/N Cass Parkway ONR	5 I-49/US-71 North of N Cass Parkway	6 I-49/US-71/MO58 OFR	7 I-49/US-71/MO-58 Interchange	8 I-49/US-71/MO58 ONR	9 I-49/US-71 North of MO58	10 I-49/US-71/163rd Cass OFR	11 I-49/US-71/163rd Street Interchange	12 I-49/US-71/163rd Street ONR	13 I-49/US-71 North of 163rd Street	14 I-49/US-71/155th Street OFR	15 I-49/US-71/155th Street Interchange	
TMS ID		019-000591-1		019-000592-1	019-000177-1	019-009882-1		019-009732-4		019-009790-2		019-010398-2				
Segment Type	Basic	Off_R	Basic	On_R	Basic	Off_R	Basic	On_R	Basic	Off_R	Basic	On_R	Basic	Off_R	Basic	
00:00:00	236	13	224	4	228	32	196	127	323	25	298	75	373	24	349	
01:00:00	141	13	129	8	137	17	120	80	200	14	186	64	250	18	232	
02:00:00	169	7	162	11	173	15	158	63	221	14	207	57	264	17	247	
03:00:00	224	13	211	14	225	20	205	96	302	56	246	85	331	20	312	
04:00:00	528	8	520	27	547	53	493	247	741	43	697	212	910	28	882	
05:00:00	1631	25	1606	122	1728	126	1602	813	2415	92	2323	636	2959	55	2904	
06:00:00	2966	99	2867	369	3236	282	2953	1681	4635	171	4464	1378	5842	91	5752	
07:00:00	2665	318	2347	572	2919	478	2441	1722	4213	404	3809	1382	5191	86	5105	
08:00:00	2196	165	2031	294	2324	355	1969	1518	3487	214	3273	1215	4488	106	4382	
09:00:00	1811	123	1688	145	1834	306	1528	1131	2658	306	2352	904	3257	116	3141	
10:00:00	1716	141	1575	109	1684	310	1374	1030	2404	172	2232	851	3083	126	2958	
11:00:00	1716	141	1575	96	1672	330	1342	1073	2415	154	2262	850	3111	131	2980	
12:00:00	1744	158	1586	99	1686	368	1318	1131	2449	190	2259	942	3201	134	3067	
13:00:00	1658	129	1529	102	1631	296	1335	1099	2433	187	2246	970	3216	137	3079	
14:00:00	1898	197	1701	94	1795	303	1491	1114	2605	158	2447	906	3353	141	3212	
15:00:00	1976	224	1753	110	1863	333	1531	1087	2618	207	2411	1111	3522	145	3377	
16:00:00	1824	373	1451	593	2044	323	1722	1005	2727	280	2447	939	3386	122	3264	
17:00:00	2000	281	1719	147	1866	368	1498	1177	2675	316	2359	1022	3381	133	3248	
18:00:00	1440	168	1272	105	1377	323	1054	974	2028	200	1828	888	2716	106	2610	
19:00:00	1068	98	970	71	1041	200	841	795	1637	164	1473	714	2187	84	2104	
20:00:00	946	88	858	66	924	155	769	695	1463	127	1336	586	1922	67	1855	
21:00:00	667	48	619	32	651	105	547	567	1114	77	1037	389	1426	55	1371	
22:00:00	482	34	449	24	472	56	417	348	765	50	714	277	991	42	949	
23:00:00	376	21	355	14	369	57	312	200	512	29	482	110	593	32	560	

*Pulled From Traffic Volume Forecast Spreadsheet

Peak Hour Volume Counts From Volume Forecast Spreadsheet
Based on count from 2019

Attachment E-1 – FREEVAL Inputs

FREEVAL Input – 2020 15-minute

Segment Name	1 I-49/US-71/155th Street Interchange	2 I-49/US-71/155th Street OFR	3 I-49/US-71 North of 163rd Street 3-2 Transition	4 I-49/US-71 North of 163rd Street	5 I-49/US-71/163rd Street OFR	6 I-49/US-71/163rd Street Interchange	7 I-49/US-71/163rd Street ONR	8 I-49/US-71 North of MO58	9 I-49/US-71/MO58 OFR	10 I-49/US-71/MO-58 Interchange	11 I-49/US-71/MO58 ONR	12 I-49/US-71 North of N Cass Parkway	13 I-49/US-71/N Cass Parkway OFR	14 I-49/US-71/N Cass Parkway Interchange	15 I-49/US-71/N Cass Parkway ONR	16 I-49/US-71/South of N Cass Parkway
TMS ID					019-010154-3		019-010295-3		019-010155-3		019-009733-2	019-000177-3	019-000589-3		019-000590-3	
Segment Type	Basic	On R	Basic	Basic	Off R	Basic	On R	Basic	Off R	Basic	On R	Basic	Off R	Basic	On R	Basic
06:00:00	1315	31	1346	1346	383	962	80	1042	303	739	117	856	39	817	79	896
06:15:00	1315	31	1346	1346	383	962	80	1042	303	739	117	856	39	817	79	896
06:30:00	1348	32	1380	1380	393	987	82	1069	311	758	120	878	41	838	81	919
06:45:00	1416	34	1449	1449	413	1036	86	1123	327	796	126	922	43	880	85	965
07:00:00	1759	47	1806	1806	569	1237	102	1339	524	815	157	971	52	919	152	1071
07:15:00	1844	59	1903	1903	615	1288	120	1408	567	841	184	1025	66	959	179	1138
07:30:00	1929	71	2001	2001	661	1339	138	1477	610	867	211	1079	80	999	206	1205
07:45:00	1844	59	1903	1903	615	1288	120	1408	567	841	184	1025	66	959	179	1138
08:00:00	2038	65	2103	2103	679	1424	130	1553	684	870	170	1040	62	978	93	1071
08:15:00	1941	62	2003	2003	647	1356	124	1479	651	828	162	990	59	932	88	1020
08:30:00	1892	60	1953	1953	631	1322	121	1442	635	807	158	965	57	908	86	995
08:45:00	1892	60	1953	1953	631	1322	121	1442	635	807	158	965	57	908	86	995
15:00:00	3924	102	4026	4026	1117	2909	184	3093	1263	1830	341	2171	159	2012	167	2179
15:15:00	3924	102	4026	4026	1117	2909	184	3093	1263	1830	341	2171	159	2012	167	2179
15:30:00	4025	104	4129	4129	1146	2983	189	3172	1295	1877	350	2227	163	2064	172	2235
15:45:00	4226	110	4336	4336	1203	3133	198	3331	1360	1971	367	2338	171	2167	180	2347
16:00:00	3849	85	3934	3934	1045	2890	288	3178	1232	1946	381	2327	224	2103	218	2321
16:15:00	4055	107	4162	4162	1130	3032	339	3371	1332	2039	417	2456	263	2193	256	2449
16:30:00	4261	129	4390	4390	1215	3175	390	3565	1432	2132	453	2585	302	2283	294	2577
16:45:00	4055	107	4162	4162	1130	3032	339	3371	1332	2039	417	2456	263	2193	256	2449
17:00:00	4228	118	4346	4346	1238	3108	269	3377	1539	1838	422	2260	274	1985	227	2213
17:15:00	4027	112	4139	4139	1179	2960	256	3216	1466	1750	402	2152	261	1891	216	2107
17:30:00	3926	109	4035	4035	1149	2886	249	3135	1429	1706	392	2098	255	1844	211	2055
17:45:00	3926	109	4035	4035	1149	2886	249	3135	1429	1706	392	2098	255	1844	211	2055
18:00:00	3575	105	3680	3680	1238	2442	170	2612	1208	1405	348	1753	169	1584	144	1439
18:15:00	3404	100	3505	3505	1179	2326	162	2488	1150	1338	331	1669	161	1508	138	1371
18:30:00	3319	98	3417	3417	1149	2268	158	2426	1121	1304	323	1627	157	1471	134	1336
18:45:00	3319	98	3417	3417	1149	2268	158	2426	1121	1304	323	1627	157	1471	134	1336

Segment Name	1 I-49/US-71/South of N Cass Parkway	2 I-49/US-71/N Cass Parkway OFR	3 I-49/US-71/N Cass Parkway Interchange	4 I-49/US-71/N Cass Parkway ONR	5 I-49/US-71 North of N Cass Parkway	6 I-49/US-71/MO58 OFR	7 I-49/US-71/MO-58 Interchange	8 I-49/US-71/MO58 ONR	9 I-49/US-71 North of MO58	10 I-49/US-71/163rd Street OFR	11 I-49/US-71/163rd Street Interchange	12 I-49/US-71/163rd Street ONR	13 I-49/US-71 North of 163rd Street	14 I-49/US-71/155th Street OFR	15 I-49/US-71/155th Street Interchange	
TMS ID		019-000591-1		019-000592-1	019-000177-1	019-009882-1		019-009732-4		019-009790-2		019-010398-2				
Segment Type	Basic	Off R	Basic	On R	Basic	Off R	Basic	On R	Basic	Off R	Basic	On R	Basic	Off R	Basic	
06:00:00	2204	73	2131	274	2405	209	2196	1250	3446	126	3320	1024	4344	67	4277	
06:15:00	2204	73	2131	274	2405	209	2196	1250	3446	126	3320	1024	4344	67	4277	
06:30:00	2261	75	2186	281	2467	215	2252	1282	3534	130	3404	1050	4454	69	4385	
06:45:00	2374	79	2295	295	2590	226	2364	1346	3710	136	3574	1103	4677	72	4605	
07:00:00	2070	141	1930	281	2210	301	1909	1300	3209	296	2913	1161	4075	71	4003	
07:15:00	2176	196	1980	353	2333	379	1954	1406	3360	372	2988	1272	4260	75	4185	
07:30:00	2282	251	2030	425	2456	457	1999	1512	3511	448	3063	1383	4445	95	4351	
07:45:00	2176	196	1980	353	2333	379	1954	1406	3360	372	2988	1272	4260	75	4185	
08:00:00	1758	132	1626	235	1861	284	1577	1215	2792	171	2621	973	3594	85	3509	
08:15:00	1675	126	1549	224	1773	271	1502	1158	2659	163	2496	926	3423	81	3342	
08:30:00	1633	123	1510	218	1728	264	1464	1129	2593	159	2434	903	3337	79	3258	
08:45:00	1633	123	1510	218	1728	264	1464	1129	2593	159	2434	903	3337	79	3258	
15:00:00	1469	166	1303	82	1385	247	1138	809	1947	154	1793	826	2619	108	2511	
15:15:00	1469	166	1303	82	1385	247	1138	809	1947	154	1793	826	2619	108	2511	
15:30:00	1507	171	1337	84	1421	254	1167	829	1996	158	1838	847	2685	111	2574	
15:45:00	1583	179	1403	88	1492	266	1226	871	2096	166	1931	890	2820	116	2704	
16:00:00	1477	196	1281	291	1572	254	1318	800	2118	224	1895	759	2654	97	2556	
16:15:00	1532	215	1317	342	1659	278	1381	866	2247	245	2002	821	2823	102	2720	
16:30:00	1587	234	1353	393	1746	302	1444	931	2375	266	2108	883	2992	122	2870	
16:45:00	1532	215	1317	342	1659	278	1381	866	2247	245	2002	821	2823	102	2720	
17:00:00	1602	225	1377	118	1494	294	1200	942	2142	253	1889	818	2707	106	2601	
17:15:00	1525	214	1311	112	1423	280	1143	897	2040	241	1799	779	2578	101	2477	
17:30:00	1487	209	1278	109	1387	273	1114	875	1989	235	1754	760	2514	99	2415	
17:45:00	1487	209	1278	109	1387	273	1114	875	1989	235	1754	760	2514	99	2415	

Attachment E-1 – FREEVAL Inputs

FREEVAL Input – 2023 15-minute

Segment Name	1 I-49/US-71/155th Street Interchange	2 I-49/US-71/155th Street OFR	3 I-49/US-71 North of 163rd Street 3-2 Transition	4 I-49/US-71 North of 163rd Street	5 I-49/US-71/163rd Street OFR	6 I-49/US-71/163rd Street Interchange	7 I-49/US-71/163rd Street ONR	8 I-49/US-71 North of MO58	9 I-49/US-71/MO58 OFR	10 I-49/US-71/MO-58 Interchange	11 I-49/US-71/MO58 ONR	12 I-49/US-71 North of N Cass Parkway	13 I-49/US-71/N Cass Parkway OFR	14 I-49/US-71/N Cass Parkway Interchange	15 I-49/US-71/N Cass Parkway ONR	16 I-49/US-71/South of N Cass Parkway
TMS ID					019-010154-3		019-010295-3		019-010155-3		019-009733-2	019-000177-3	019-000589-3		019-000590-3	
Segment Type	Basic	On R	Basic	Basic	Off R	Basic	On R	Basic	Off R	Basic	On R	Basic	Off R	Basic	On R	Basic
06:00:00	1358	32	1390	1390	396	994	83	1077	313	763	121	885	41	844	82	925
06:15:00	1358	32	1390	1390	396	994	83	1077	313	763	121	885	41	844	82	925
06:30:00	1393	33	1426	1426	406	1020	85	1104	322	783	124	907	42	865	84	949
06:45:00	1463	35	1497	1497	427	1071	89	1160	338	822	131	953	44	909	88	997
07:00:00	1800	48	1847	1847	574	1273	103	1376	539	837	161	998	56	942	162	1104
07:15:00	1887	60	1947	1947	621	1326	121	1447	583	864	189	1053	70	983	190	1173
07:30:00	1974	72	2047	2047	668	1379	139	1518	627	891	217	1108	84	1024	218	1242
07:45:00	1887	60	1947	1947	621	1326	121	1447	583	864	189	1053	70	983	190	1173
08:00:00	2105	67	2172	2172	702	1471	134	1605	706	898	176	1074	64	1011	96	1106
08:15:00	2005	64	2069	2069	668	1401	128	1528	673	856	167	1023	61	962	91	1054
08:30:00	1955	62	2017	2017	652	1366	125	1490	656	834	163	997	59	938	89	1027
08:45:00	1955	62	2017	2017	652	1366	125	1490	656	834	163	997	59	938	89	1027
15:00:00	4054	105	4159	4159	1154	3005	190	3195	1304	1891	352	2243	164	2078	173	2251
15:15:00	4054	105	4159	4159	1154	3005	190	3195	1304	1891	352	2243	164	2078	173	2251
15:30:00	4158	108	4266	4266	1184	3082	195	3277	1338	1939	361	2300	168	2132	177	2309
15:45:00	4366	113	4479	4479	1243	3236	205	3441	1405	2036	379	2415	177	2238	186	2425
16:00:00	3934	87	4020	4020	1062	2959	293	3252	1254	1998	387	2385	239	2146	232	2379
16:15:00	4144	109	4253	4253	1148	3105	345	3450	1356	2094	424	2518	281	2237	273	2510
16:30:00	4354	131	4486	4486	1234	3251	397	3648	1458	2190	461	2651	323	2328	314	2641
16:45:00	4144	109	4253	4253	1148	3105	345	3450	1356	2094	424	2518	281	2237	273	2510
17:00:00	4368	121	4489	4489	1279	3211	277	3488	1590	1898	436	2334	283	2051	235	2286
17:15:00	4160	116	4276	4276	1218	3058	264	3322	1514	1808	415	2223	270	1953	224	2177
17:30:00	4056	113	4169	4169	1187	2981	258	3239	1476	1763	405	2168	263	1905	218	2123
17:45:00	4056	113	4169	4169	1187	2981	258	3239	1476	1763	405	2168	263	1905	218	2123
18:00:00	3390	109	3499	3499	976	2523	176	2699	1248	1451	360	1811	175	1636	149	1785
18:15:00	3229	104	3332	3332	929	2403	167	2570	1188	1382	342	1724	166	1558	142	1700
18:30:00	3148	101	3249	3249	906	2343	163	2506	1158	1347	334	1681	162	1519	138	1658
18:45:00	3148	101	3249	3249	906	2343	163	2506	1158	1347	334	1681	162	1519	138	1658

Segment Name	1 I-49/US-71/South of N Cass Parkway	2 I-49/US-71/N Cass Parkway OFR	3 I-49/US-71/N Cass Parkway Interchange	4 I-49/US-71/N Cass Parkway ONR	5 I-49/US-71 North of N Cass Parkway	6 I-49/US-71/MO58 OFR	7 I-49/US-71/MO-58 Interchange	8 I-49/US-71/MO58 ONR	9 I-49/US-71 North of MO58	10 I-49/US-71/163rd Street OFR	11 I-49/US-71/163rd Street Interchange	12 I-49/US-71/163rd Street ONR	13 I-49/US-71 North of 163rd Street	14 I-49/US-71/155th Street OFR	15 I-49/US-71/155th Street Interchange	
TMS ID		019-000591-1		019-000592-1	019-000177-1	019-009882-1		019-009732-4		019-009790-2		019-010398-2				
Segment Type	Basic	Off R	Basic	On R	Basic	Off R	Basic	On R	Basic	Off R	Basic	On R	Basic	Off R	Basic	
06:00:00	2278	76	2202	283	2485	217	2269	1292	3560	131	3429	1059	4488	70	4418	
06:15:00	2278	76	2202	283	2485	217	2269	1292	3560	131	3429	1059	4488	70	4418	
06:30:00	2337	78	2258	291	2549	222	2327	1325	3651	134	3517	1086	4603	72	4531	
06:45:00	2453	82	2371	305	2677	234	2443	1391	3834	141	3693	1140	4833	75	4758	
07:00:00	2123	149	1973	297	2271	310	1961	1337	3298	299	2999	1188	4187	72	4115	
07:15:00	2231	208	2023	374	2397	390	2007	1446	3453	376	3077	1285	4362	76	4286	
07:30:00	2339	267	2073	451	2523	470	2053	1555	3608	453	3155	1397	4552	96	4455	
07:45:00	2231	208	2023	374	2397	390	2007	1446	3453	376	3077	1285	4362	76	4286	
08:00:00	1816	136	1680	243	1923	294	1629	1256	2885	177	2708	1005	3713	88	3625	
08:15:00	1730	130	1600	231	1831	280	1551	1196	2747	168	2579	957	3536	84	3452	
08:30:00	1687	127	1560	225	1785	273	1513	1166	2679	164	2514	933	3447	82	3366	
08:45:00	1687	127	1560	225	1785	273	1513	1166	2679	164	2514	933	3447	82	3366	
15:00:00	1518	172	1346	85	1431	256	1176	835	2011	159	1852	854	2705	112	2594	
15:15:00	1518	172	1346	85	1431	256	1176	835	2011	159	1852	854	2705	112	2594	
15:30:00	1557	176	1381	87	1468	262	1206	857	2062	163	1899	875	2775	115	2660	
15:45:00	1635	185	1450	91	1541	275	1266	900	2166	171	1994	919	2914	120	2793	
16:00:00	1292	210	1082	310	1393	258	1134	816	1950	227	1723	771	2494	99	2395	
16:15:00	1335	230	1105	365	1470	283	1187	882	2069	249	1820	834	2654	104	2550	
16:30:00	1378	250	1128	420	1547	308	1240	948	2188	271	1918	897	2814	124	2690	
16:45:00	1335	230	1105	365	1470	283	1187	882	2069	249	1820	834	2654	104	2550	
17:00:00	1655	232	1422	121	1544	304	1239	974	2213	261	1952	845	2797	110	2687	
17:15:00	1576	221	1354	116	1470	290	1180	927	2108	249	1859	805	2664	105	2559	
17:30:00	1536	216	1321	113	1433	282	1151	904	2055	243	1812	785	2597	102	2495	
17:45:00	1536	216	1321	113	1433	282	1151	904	2055	243	1812	785	2597	102	2495	

Attachment E-1 – FREEVAL Inputs

FREEVAL Input – 2045 15-minute

Segment Name	1 I-49/US-71/155th Street Interchange	2 I-49/US-71/155th Street OFR	3 I-49/US-71 North of 163rd Street 3-2 Transition	4 I-49/US-71 North of 163rd Street	5 I-49/US-71/163rd Street OFR	6 I-49/US-71/163rd Street Interchange	7 I-49/US-71/163rd Street ONR	8 I-49/US-71 North of MO58	9 I-49/US-71/MO58 OFR	10 I-49/US-71/MO-58 Interchange	11 I-49/US-71/MO58 ONR	12 I-49/US-71 North of N Cass Parkway	13 I-49/US-71/N Cass Parkway OFR	14 I-49/US-71/N Cass Parkway Interchange	15 I-49/US-71/N Cass Parkway ONR	16 I-49/US-71/South of N Cass Parkway
TMS ID					019-010154-3		019-010295-3		019-010155-3		019-009733-2	019-000177-3	019-000589-3		019-000590-3	
Segment Type	Basic	On R	Basic	Basic	Off R	Basic	On R	Basic	Off R	Basic	On R	Basic	Off R	Basic	On R	Basic
06:00:00	1724	41	1765	1765	503	1262	105	1367	398	969	154	1123	52	1071	104	1175
06:15:00	1724	41	1765	1765	503	1262	105	1367	398	969	154	1123	52	1071	104	1175
06:30:00	1768	42	1810	1810	516	1294	108	1402	408	994	158	1152	53	1099	106	1205
06:45:00	1857	44	1901	1901	542	1359	113	1472	429	1043	166	1209	56	1154	112	1265
07:00:00	2134	52	2186	2186	618	1568	111	1678	661	1017	197	1215	85	1129	248	1377
07:15:00	2238	65	2303	2303	668	1635	130	1765	715	1050	232	1282	107	1175	291	1466
07:30:00	2342	78	2420	2420	718	1702	149	1852	769	1083	267	1349	129	1221	334	1555
07:45:00	2238	65	2303	2303	668	1635	130	1765	715	1050	232	1282	107	1175	291	1466
08:00:00	2673	85	2758	2758	891	1867	170	2037	897	1140	223	1363	81	1283	122	1404
08:15:00	2545	81	2626	2626	848	1778	162	1940	854	1086	212	1298	77	1222	116	1338
08:30:00	2482	79	2561	2561	827	1733	158	1892	833	1059	207	1266	75	1191	113	1304
08:45:00	2482	79	2561	2561	827	1733	158	1892	833	1059	207	1266	75	1191	113	1304
15:00:00	5146	134	5279	5279	1465	3814	241	4056	1656	2400	447	2847	209	2638	219	2858
15:15:00	5146	134	5279	5279	1465	3814	241	4056	1656	2400	447	2847	209	2638	219	2858
15:30:00	5278	137	5415	5415	1503	3912	247	4160	1698	2461	458	2920	214	2706	225	2931
15:45:00	5542	144	5686	5686	1578	4108	260	4368	1783	2584	481	3066	225	2841	236	3078
16:00:00	4620	98	4718	4718	1195	3523	330	3853	1429	2425	441	2866	388	2478	377	2855
16:15:00	4668	123	4991	4991	1292	3699	368	4087	1545	2542	483	3025	456	2569	443	3012
16:30:00	5116	148	5264	5264	1389	3875	446	4321	1661	2659	525	3184	524	2660	509	3169
16:45:00	4668	123	4991	4991	1292	3699	388	4087	1545	2542	483	3025	456	2569	443	3012
17:00:00	5545	154	5699	5699	1623	4076	352	4428	2018	2410	553	3963	360	2604	298	2901
17:15:00	5281	147	5427	5427	1546	3881	335	4217	1922	2295	527	2822	342	2480	284	2763
17:30:00	5149	143	5292	5292	1507	3784	327	4111	1874	2238	514	2751	334	2418	277	2694
17:45:00	5149	143	5292	5292	1507	3784	327	4111	1874	2238	514	2751	334	2418	277	2694
18:00:00	4303	138	4441	4441	1239	3202	223	3425	1584	1842	456	2298	222	2077	189	2266
18:15:00	4098	131	4229	4229	1180	3050	212	3262	1508	1754	435	2189	211	1978	180	2158
18:30:00	3996	128	4124	4124	1150	2974	207	3181	1470	1710	424	2134	206	1928	176	2104
18:45:00	3996	128	4124	4124	1150	2974	207	3181	1470	1710	424	2134	206	1928	176	2104

Segment Name	1 I-49/US-71/South of N Cass Parkway	2 I-49/US-71/N Cass Parkway OFR	3 I-49/US-71/N Cass Parkway Interchange	4 I-49/US-71/N Cass Parkway ONR	5 I-49/US-71 North of N Cass Parkway	6 I-49/US-71/MO58 OFR	7 I-49/US-71/MO-58 Interchange	8 I-49/US-71/MO58 ONR	9 I-49/US-71 North of MO58	10 I-49/US-71/163rd Street OFR	11 I-49/US-71/163rd Street Interchange	12 I-49/US-71/163rd Street ONR	13 I-49/US-71 North of 163rd Street	14 I-49/US-71/155th Street OFR	15 I-49/US-71/155th Street Interchange	
TMS ID		019-000591-1		019-000592-1	019-000177-1	019-009882-1		019-009732-4		019-009790-2		019-010398-2				
Segment Type	Basic	Off R	Basic	On R	Basic	Off R	Basic	On R	Basic	Off R	Basic	On R	Basic	Off R	Basic	
06:00:00	2892	97	2795	360	3155	275	2880	1639	4519	166	4353	1344	5696	89	5608	
06:15:00	2892	97	2795	360	3155	275	2880	1639	4519	166	4353	1344	5696	89	5608	
06:30:00	2966	99	2867	369	3236	282	2953	1681	4635	171	4464	1378	5842	91	5752	
06:45:00	3114	104	3010	387	3398	296	3101	1766	4867	179	4688	1447	6135	95	6039	
07:00:00	2539	228	2311	455	2765	380	2385	1592	3978	321	3656	1278	4934	62	4873	
07:15:00	2665	318	2347	572	2919	478	2441	1722	4163	404	3759	1382	5141	86	5055	
07:30:00	2791	408	2383	689	3073	576	2497	1852	4348	487	3862	1502	5364	110	5254	
07:45:00	2665	318	2347	572	2919	478	2441	1722	4163	404	3759	1382	5141	86	5055	
08:00:00	2306	173	2132	308	2441	373	2068	1594	3662	225	3437	1275	4712	112	4601	
08:15:00	2196	165	2031	294	2324	355	1969	1518	3487	214	3273	1215	4488	106	4382	
08:30:00	2141	161	1980	286	2266	346	1920	1480	3400	209	3192	1184	4376	104	4272	
08:45:00	2141	161	1980	286	2266	346	1920	1480	3400	209	3192	1184	4376	104	4272	
15:00:00	1927	218	1709	108	1817	324	1492	1060	2552	202	2351	1083	3434	99	3335	
15:15:00	1927	218	1709	108	1817	324	1492	1060	2552	202	2351	1083	3434	104	3330	
15:30:00	1976	224	1753	110	1863	333	1531	1087	2618	207	2411	1111	3522	122	3401	
15:45:00	2075	235	1840	116	1956	349	1607	1142	2749	217	2532	1167	3698	104	3594	
16:00:00	1773	341	1432	504	1936	295	1642	929	2571	256	2315	868	3184	99	3085	
16:15:00	1824	373	1451	593	2044	323	1721	1005	2726	280	2446	939	3385	104	3281	
16:30:00	1875	405	1470	682	2152	351	1800	1081	2881	304	2577	1010	3586	124	3462	
16:45:00	1824	373	1451	593	2044	323	1721	1005	2726	280	2446	939	3385	104	3281	
17:00:00	2100	295	1805	154	1959	386	1573	1236	2809	332	2477	1073	3550	99	3451	
17:15:00	2000	281	1719	147	1866	368	1498	1177	2675	316	2359	1022	3381	104	3277	
17:30:00	1950	274	1676	143	1819	358	1461	1147	2608	308	2300	996	3297	64	3233	
17:45:00	1950	274	1676	143	1819	358	1461	1147	2608	308	2300	996	3297	104	3192	



ATTACHMENT E2: FREEVAL Results

Appendix E-2 – FREEVAL Results

2020 – Base Year

Description	Type	AM Peak Period		PM Peak Period	
		Density (veh/mi/lane)	V/C	Density (veh/mi/lane)	V/C
I-49 Corridor - Southbound					
I-49/US-71/155th Street Interchange	Basic	9.51	0.43	49.78	0.87
I-49/US-71/155th Street	On Ramp	8.75	0.48	47.31	0.95
I-49/US-71 North of 163rd Street 3-2 Transition	Basic	9.82	0.47	48.96	1.00
I-49/US-71 North of 163rd Street	Basic	14.71	0.47	53.40	0.92
I-49/US-71/163rd Street	Off Ramp	14.02	0.48	34.26	1.00
I-49/US-71/163rd Street Interchange	Basic	10.07	0.41	27.25	0.85
I-49/US-71/163rd Street	On Ramp	10.24	0.38	24.60	0.82
I-49/US-71 North of MO58	Basic	10.44	0.34	24.56	0.73
I-49/US-71/MO58	Off Ramp	0.34	0.39	15.53	0.84
I-49/US-71/MO-58 Interchange	Basic	6.29	0.24	13.75	0.56
I-49/US-71/MO58	On Ramp	8.57	0.24	17.98	0.55
I-49/US-71 North of N Cass Parkway	Basic	7.28	0.24	16.05	0.55
I-49/US-71/N Cass Parkway	Off Ramp	6.91	0.27	17.44	0.60
I-49/US-71/N Cass Parkway Interchange	Basic	6.87	0.23	14.46	0.51
I-49/US-71/N Cass Parkway	On Ramp	8.20	0.35	17.09	0.71
I-49/US-71/South of N Cass Parkway	Basic	7.76	0.27	15.97	0.55
I-49 Corridor - Northbound					
I-49/US-71/South of N Cass Parkway	Basic	16.10	0.59	11.97	0.37
I-49/US-71/N Cass Parkway	Off Ramp	16.31	0.62	11.49	0.40
I-49/US-71/N Cass Parkway Interchange	Basic	15.11	0.58	10.50	0.37
I-49/US-71/N Cass Parkway	On Ramp	18.21	0.63	12.47	0.55
I-49/US-71 North of N Cass Parkway	Basic	17.23	0.60	11.83	0.41
I-49/US-71/MO58	Off Ramp	16.99	0.58	10.64	0.48
I-49/US-71/MO-58 Interchange	Basic	15.07	0.58	9.81	0.39
I-49/US-71/MO58	On Ramp	26.54	1.00	17.68	0.54
I-49/US-71 North of MO58	Basic	30.32	0.90	17.14	0.54
I-49/US-71/163rd Street	Off Ramp	26.69	0.92	16.77	0.54
I-49/US-71/163rd Street Interchange	Basic	27.93	0.90	15.45	0.48
I-49/US-71/163rd Street	On Ramp	34.27	1.00	23.24	0.73
I-49/US-71 North of 163rd Street	Basic	38.51	0.98	22.70	0.69
I-49/US-71/155th Street	Off Ramp	26.25	0.81	19.39	0.46
I-49/US-71/155th Street Interchange	Basic	24.32	0.80	14.41	0.44

Appendix E-2 – FREEVAL Results

2023 – No-Build

Description	Type	AM Peak Period		PM Peak Period	
		Density (veh/mi/lane)	V/C	Density (veh/mi/lane)	V/C
I-49 Corridor - Southbound					
I-49/US-71/155th Street Interchange	Basic	9.8	0.44	55.6	0.87
I-49/US-71/155th Street	On Ramp	9.0	0.50	41.3	1.00
I-49/US-71 North of 163rd Street 3-2 Transition	Basic	10.1	0.49	44.4	1.00
I-49/US-71 North of 163rd Street	Basic	15.1	0.48	50.4	0.95
I-49/US-71/163rd Street	Off Ramp	14.5	0.50	34.2	1.00
I-49/US-71/163rd Street Interchange	Basic	10.4	0.42	27.8	0.88
I-49/US-71/163rd Street	On Ramp	10.6	0.39	24.9	0.82
I-49/US-71 North of MO58	Basic	10.8	0.35	24.9	0.74
I-49/US-71/MO58	Off Ramp	0.0	0.40	15.9	0.84
I-49/US-71/MO-58 Interchange	Basic	6.5	0.25	13.8	0.56
I-49/US-71/MO58	On Ramp	8.8	0.25	18.0	0.55
I-49/US-71 North of N Cass Parkway	Basic	7.5	0.25	16.1	0.55
I-49/US-71/N Cass Parkway	Off Ramp	7.2	0.27	17.5	0.61
I-49/US-71/N Cass Parkway Interchange	Basic	7.1	0.24	14.5	0.51
I-49/US-71/N Cass Parkway	On Ramp	8.5	0.36	17.2	0.72
I-49/US-71/South of N Cass Parkway	Basic	8.0	0.28	16.0	0.56
I-49 Corridor - Northbound					
I-49/US-71/South of N Cass Parkway	Basic	16.6	0.61	11.7	0.41
I-49/US-71/N Cass Parkway	Off Ramp	16.9	0.64	11.2	0.43
I-49/US-71/N Cass Parkway Interchange	Basic	15.6	0.60	10.2	0.37
I-49/US-71/N Cass Parkway	On Ramp	18.8	0.65	12.2	0.38
I-49/US-71 North of N Cass Parkway	Basic	18.0	0.61	11.6	0.36
I-49/US-71/MO58	Off Ramp	32.7	0.58	10.3	0.35
I-49/US-71/MO-58 Interchange	Basic	38.6	0.58	9.5	0.32
I-49/US-71/MO58	On Ramp	32.7	1.00	17.5	0.66
I-49/US-71 North of MO58	Basic	37.9	0.90	17.1	0.59
I-49/US-71/163rd Street	Off Ramp	37.2	0.92	16.6	0.60
I-49/US-71/163rd Street Interchange	Basic	42.7	0.88	15.3	0.56
I-49/US-71/163rd Street	On Ramp	35.3	1.00	23.2	0.67
I-49/US-71 North of 163rd Street	Basic	39.9	0.98	22.7	0.66
I-49/US-71/155th Street	Off Ramp	26.9	0.82	19.2	0.55
I-49/US-71/155th Street Interchange	Basic	25.1	0.80	14.4	0.53

Appendix E-2 – FREEVAL Results

2023 – Build

Description	Type	AM Peak Period		PM Peak Period	
		Density (veh/mi/lane)	V/C	Density (veh/mi/lane)	V/C
I-49 Corridor - Southbound					
I-49/US-71/155th Street Interchange	Basic	9.8	0.32	21.8	0.66
I-49/US-71/155th Street	On Ramp	9.0	0.33	20.2	0.68
I-49/US-71 North of 163rd Street 3-2 Transition	Basic	10.1	0.33	22.4	0.68
I-49/US-71 North of 163rd Street	Basic	10.1	0.32	22.4	0.67
I-49/US-71/163rd Street	Off Ramp	10.9	0.33	24.0	0.69
I-49/US-71/163rd Street Interchange	Basic	6.9	0.28	16.3	0.62
I-49/US-71/163rd Street	On Ramp	6.5	0.26	16.7	0.59
I-49/US-71 North of MO58	Basic	7.2	0.23	16.6	0.53
I-49/US-71/MO58	Off Ramp	2.3	0.27	11.8	0.61
I-49/US-71/MO-58 Interchange	Basic	4.3	0.17	9.4	0.41
I-49/US-71/MO58	On Ramp	6.1	0.16	12.6	0.39
I-49/US-71 North of N Cass Parkway	Basic	5.0	0.16	11.0	0.39
I-49/US-71/N Cass Parkway	Off Ramp	4.9	0.18	12.5	0.43
I-49/US-71/N Cass Parkway Interchange	Basic	4.7	0.16	9.9	0.36
I-49/US-71/N Cass Parkway	On Ramp	5.4	0.24	11.2	0.51
I-49/US-71/South of N Cass Parkway	Basic	5.3	0.19	11.0	0.40
I-49 Corridor - Northbound					
I-49/US-71/South of N Cass Parkway	Basic	11.0	0.40	7.8	0.27
I-49/US-71/N Cass Parkway	Off Ramp	11.3	0.43	7.7	0.29
I-49/US-71/N Cass Parkway Interchange	Basic	10.3	0.40	6.8	0.25
I-49/US-71/N Cass Parkway	On Ramp	12.2	0.43	7.9	0.25
I-49/US-71 North of N Cass Parkway	Basic	11.8	0.42	7.7	0.24
I-49/US-71/MO58	Off Ramp	11.8	0.40	7.1	0.23
I-49/US-71/MO-58 Interchange	Basic	10.3	0.40	6.3	0.21
I-49/US-71/MO58	On Ramp	20.7	0.76	13.5	0.44
I-49/US-71 North of MO58	Basic	18.8	0.76	11.3	0.44
I-49/US-71/163rd Street	Off Ramp	18.0	0.68	11.4	0.39
I-49/US-71/163rd Street Interchange	Basic	16.8	0.67	10.2	0.37
I-49/US-71/163rd Street	On Ramp	25.0	0.74	16.9	0.45
I-49/US-71 North of 163rd Street	Basic	23.4	0.74	15.1	0.45
I-49/US-71/155th Street	Off Ramp	26.8	0.73	19.2	0.44
I-49/US-71/155th Street Interchange	Basic	22.7	0.73	14.4	0.43

Appendix E-2 – FREEVAL Results

2045 – No-Build

Description	Type	AM Peak Period		PM Peak Period	
		Density (veh/mi/lane)	V/C	Density (veh/mi/lane)	V/C
I-49 Corridor - Southbound					
I-49/US-71/155th Street Interchange	Basic	12.2	0.56	74.2	0.83
I-49/US-71/155th Street	On Ramp	11.2	0.63	64.4	0.93
I-49/US-71 North of 163rd Street 3-2 Transition	Basic	12.8	0.62	63.7	0.93
I-49/US-71 North of 163rd Street	Basic	18.8	0.61	62.2	0.91
I-49/US-71/163rd Street	Off Ramp	18.4	0.63	34.5	1.00
I-49/US-71/163rd Street Interchange	Basic	13.1	0.53	26.5	0.96
I-49/US-71/163rd Street	On Ramp	13.4	0.50	24.5	0.87
I-49/US-71 North of MO58	Basic	13.5	0.45	24.5	0.78
I-49/US-71/MO58	Off Ramp	3.2	0.51	15.5	0.90
I-49/US-71/MO-58 Interchange	Basic	8.1	0.32	12.4	0.77
I-49/US-71/MO58	On Ramp	10.8	0.30	16.9	0.71
I-49/US-71 North of N Cass Parkway	Basic	9.4	0.30	15.3	0.71
I-49/US-71/N Cass Parkway	Off Ramp	9.4	0.33	16.4	0.78
I-49/US-71/N Cass Parkway Interchange	Basic	8.8	0.30	13.2	0.72
I-49/US-71/N Cass Parkway	On Ramp	10.7	0.45	16.2	0.93
I-49/US-71/South of N Cass Parkway	Basic	10.1	0.35	15.4	0.73
I-49 Corridor - Northbound					
I-49/US-71/South of N Cass Parkway	Basic	77.0	0.71	15.2	0.52
I-49/US-71/N Cass Parkway	Off Ramp	66.1	0.75	15.3	0.55
I-49/US-71/N Cass Parkway Interchange	Basic	78.2	0.71	13.1	0.47
I-49/US-71/N Cass Parkway	On Ramp	79.8	0.76	16.0	0.52
I-49/US-71 North of N Cass Parkway	Basic	93.4	0.74	15.2	0.50
I-49/US-71/MO58	Off Ramp	103.8	0.68	14.6	0.48
I-49/US-71/MO-58 Interchange	Basic	112.5	0.60	12.6	0.45
I-49/US-71/MO58	On Ramp	38.2	1.00	22.5	0.85
I-49/US-71 North of MO58	Basic	40.1	0.83	23.2	0.77
I-49/US-71/163rd Street	Off Ramp	38.3	0.85	22.1	0.78
I-49/US-71/163rd Street Interchange	Basic	40.2	0.85	20.7	0.72
I-49/US-71/163rd Street	On Ramp	36.1	1.00	29.3	0.85
I-49/US-71 North of 163rd Street	Basic	41.8	0.98	29.8	0.84
I-49/US-71/155th Street	Off Ramp	27.4	0.82	23.2	0.70
I-49/US-71/155th Street Interchange	Basic	26.2	0.80	19.0	0.68

Appendix E-2 – FREEVAL Results

2045 – Build					
Description	Type	AM Peak Period		PM Peak Period	
		Density (veh/mi/lane)	V/C	Density (veh/mi/lane)	V/C
I-49 Corridor - Southbound					
I-49/US-71/155th Street Interchange	Basic	12.1	0.40	27.8	0.84
I-49/US-71/155th Street	On Ramp	11.2	0.42	25.4	0.86
I-49/US-71 North of 163rd Street 3-2 Transition	Basic	12.5	0.42	28.8	0.86
I-49/US-71 North of 163rd Street	Basic	12.5	0.41	28.5	0.84
I-49/US-71/163rd Street	Off Ramp	13.7	0.42	29.0	0.87
I-49/US-71/163rd Street Interchange	Basic	8.7	0.35	21.5	0.78
I-49/US-71/163rd Street	On Ramp	8.3	0.33	21.7	0.72
I-49/US-71 North of MO58	Basic	9.0	0.30	20.8	0.65
I-49/US-71/MO58	Off Ramp	0.1	0.34	17.7	0.74
I-49/US-71/MO-58 Interchange	Basic	5.4	0.21	11.8	0.49
I-49/US-71/MO58	On Ramp	7.4	0.20	15.5	0.47
I-49/US-71 North of N Cass Parkway	Basic	6.3	0.20	13.8	0.47
I-49/US-71/N Cass Parkway	Off Ramp	6.5	0.22	15.8	0.52
I-49/US-71/N Cass Parkway Interchange	Basic	5.9	0.20	12.3	0.44
I-49/US-71/N Cass Parkway	On Ramp	6.9	0.30	14.1	0.61
I-49/US-71/South of N Cass Parkway	Basic	6.7	0.23	13.7	0.48
I-49 Corridor - Northbound					
I-49/US-71/South of N Cass Parkway	Basic	13.7	0.51	10.1	0.35
I-49/US-71/N Cass Parkway	Off Ramp	14.4	0.54	10.6	0.37
I-49/US-71/N Cass Parkway Interchange	Basic	12.7	0.51	8.7	0.31
I-49/US-71/N Cass Parkway	On Ramp	15.4	0.55	10.5	0.35
I-49/US-71 North of N Cass Parkway	Basic	14.8	0.53	10.1	0.33
I-49/US-71/MO58	Off Ramp	15.2	0.51	10.0	0.32
I-49/US-71/MO-58 Interchange	Basic	12.9	0.51	8.4	0.30
I-49/US-71/MO58	On Ramp	25.7	0.96	17.0	0.57
I-49/US-71 North of MO58	Basic	26.4	0.96	14.7	0.57
I-49/US-71/163rd Street	Off Ramp	22.2	0.87	14.9	0.51
I-49/US-71/163rd Street Interchange	Basic	22.0	0.85	13.2	0.47
I-49/US-71/163rd Street	On Ramp	30.6	0.94	21.2	0.57
I-49/US-71 North of 163rd Street	Basic	30.3	0.94	19.2	0.57
I-49/US-71/155th Street	Off Ramp	31.5	0.92	23.2	0.56
I-49/US-71/155th Street Interchange	Basic	29.6	0.92	18.5	0.55

ATTACHMENT E3: SPEED DATA

Attachment E-3 – Speed Data

Speed by Time and Location – Northbound								
Time	Mile 11.0	MO-58	Mile 13.0	Route Y	Mile 15.0	Mile 16.0	Mile 17.0	Average Speed
00:00	66.9	66.9	64.5	64.5	64.4	64.4	63.9	65.0
00:15	67.5	67.5	65.0	65.0	64.8	64.8	64.6	65.6
00:30	67.5	67.5	64.9	64.9	64.7	64.8	64.7	65.6
00:45	67.1	67.1	64.4	64.4	63.8	63.8	64.4	65.0
01:00	67.4	67.4	65.0	65.0	64.3	64.3	64.3	65.4
01:15	67.7	67.7	65.2	65.1	64.5	64.5	64.5	65.6
01:30	67.7	67.7	65.0	65.0	64.1	64.2	64.2	65.4
01:45	67.6	67.6	64.8	64.8	64.2	64.3	64.4	65.4
02:00	67.8	67.8	64.8	64.8	64.4	64.4	64.4	65.5
02:15	68.3	68.3	64.8	64.8	64.6	64.6	64.8	65.7
02:30	67.7	67.7	64.7	64.8	64.3	64.2	64.3	65.4
02:45	67.7	67.7	64.8	64.8	64.2	64.1	64.8	65.4
03:00	68.1	68.1	65.2	65.2	64.8	64.8	65.1	65.9
03:15	68.3	68.3	65.4	65.4	65.4	65.4	65.6	66.3
03:30	68.4	68.4	65.8	65.8	65.2	65.2	65.4	66.3
03:45	68.5	68.5	65.7	65.8	65.3	65.2	65.0	66.3
04:00	68.5	68.5	65.8	65.8	65.4	65.4	65.3	66.4
04:15	68.4	68.4	65.7	65.8	65.3	65.2	65.5	66.3
04:30	68.8	68.7	66.3	66.3	65.8	65.7	65.8	66.8
04:45	68.9	68.9	67.0	67.2	66.4	66.4	66.6	67.3
05:00	69.0	69.0	66.9	66.9	66.5	66.5	67.0	67.4
05:15	69.8	69.8	67.4	67.5	66.9	66.9	66.7	67.8
05:30	71.4	71.5	68.5	68.7	68.2	68.2	68.3	69.3
05:45	71.7	71.7	69.0	69.1	68.4	68.4	68.7	69.6
06:00	72.1	72.1	67.9	67.9	67.2	67.2	67.9	68.9
06:15	71.0	71.0	63.5	63.5	63.9	63.8	65.7	66.1
06:30	69.0	68.9	51.8	51.5	57.7	57.7	60.5	59.6
06:45	67.8	67.8	47.6	47.3	55.2	55.3	58.3	57.0
07:00	68.9	68.9	52.0	52.1	57.6	57.8	59.1	59.5
07:15	68.0	68.0	48.1	48.5	54.3	54.5	56.8	56.9
07:30	67.0	67.3	45.3	46.1	53.8	53.6	56.1	55.6
07:45	68.1	68.5	51.7	52.5	56.8	56.6	56.6	58.7
08:00	69.2	69.2	59.2	60.2	59.6	59.6	59.4	62.3
08:15	69.5	69.5	62.3	63.5	61.4	61.4	61.4	64.1
08:30	69.0	69.0	63.7	65.0	62.5	62.4	62.4	64.9
08:45	68.8	68.8	64.4	65.4	63.0	63.3	63.3	65.3
09:00	69.0	69.0	64.7	65.5	63.6	64.1	64.0	65.7
09:15	69.3	69.3	64.9	65.4	63.9	64.4	65.0	66.0
09:30	69.4	69.3	64.9	65.4	63.8	64.2	64.8	66.0
09:45	69.3	69.3	65.3	65.5	64.0	64.1	64.8	66.0
10:00	69.0	68.9	65.8	65.8	64.3	64.3	64.7	66.1
10:15	68.9	68.9	65.3	65.3	64.0	64.0	64.7	65.9
10:30	68.8	68.8	65.5	65.5	64.3	64.3	64.9	66.0
10:45	69.0	68.9	65.5	65.5	64.2	64.2	64.8	66.0
11:00	69.0	68.9	65.7	65.7	64.1	64.2	64.7	66.0
11:15	69.2	69.2	65.6	65.6	64.4	64.4	64.9	66.2
11:30	69.1	69.1	65.4	65.4	64.4	64.4	64.9	66.1
11:45	69.0	69.1	65.5	65.5	64.6	64.5	65.2	66.2
12:00	69.0	69.0	65.5	65.4	64.5	64.5	65.0	66.1
12:15	68.9	69.0	65.3	65.3	64.3	64.2	65.0	66.0
12:30	69.1	69.1	65.5	65.5	64.5	64.5	65.0	66.2
12:45	69.2	69.2	65.3	65.2	63.9	64.1	64.7	66.0
13:00	69.4	69.4	65.8	65.7	64.4	64.5	65.0	66.3
13:15	68.8	68.9	65.4	65.4	64.3	64.3	65.1	66.0
13:30	68.9	68.9	65.6	65.7	64.4	64.4	65.0	66.1
13:45	69.1	69.1	65.6	65.7	64.5	64.6	65.1	66.2
14:00	69.4	69.4	66.0	66.1	64.8	64.8	65.2	66.5
14:15	69.3	69.3	65.7	65.7	64.3	64.3	64.9	66.2
14:30	69.1	69.1	65.7	65.7	64.2	64.2	65.0	66.1
14:45	69.2	69.3	65.9	65.9	64.6	64.5	65.0	66.3
15:00	69.1	69.2	65.6	65.6	64.7	64.7	65.3	66.3
15:15	69.4	69.4	65.7	65.7	64.6	64.6	65.2	66.4
15:30	69.6	69.6	66.1	66.0	64.6	64.6	65.1	66.5
15:45	69.6	69.6	66.1	66.1	64.8	64.8	64.8	66.5
16:00	69.6	69.6	65.9	65.9	64.6	64.6	65.0	66.5
16:15	69.8	69.8	65.9	65.9	64.5	64.6	65.0	66.5
16:30	69.6	69.6	65.9	65.9	64.7	64.7	65.3	66.5
16:45	70.0	70.0	66.5	66.5	65.1	65.2	65.6	67.0
17:00	69.8	69.8	66.3	66.2	65.1	65.1	65.5	66.8
17:15	70.1	70.1	66.4	66.3	64.9	64.8	65.6	66.9
17:30	69.8	69.8	66.4	66.4	65.3	65.4	65.7	67.0
17:45	69.4	69.4	66.2	66.2	65.4	65.5	65.8	66.8
18:00	69.2	69.1	66.1	66.1	65.2	65.3	65.8	66.7
18:15	69.3	69.3	66.2	66.1	65.2	65.1	65.9	66.7
18:30	69.3	69.3	66.4	66.4	65.6	65.6	66.1	66.9
18:45	69.5	69.5	66.1	66.0	65.2	65.1	66.0	66.8
19:00	69.7	69.7	66.4	66.4	65.4	65.4	66.1	67.0
19:15	69.5	69.4	66.3	66.2	65.6	65.6	65.9	66.9
19:30	69.1	69.1	65.9	65.8	65.6	65.6	66.0	66.7
19:45	69.1	69.0	65.9	65.9	65.7	65.7	66.1	66.8
20:00	69.1	69.1	66.1	66.1	65.3	65.3	65.7	66.7
20:15	68.9	68.9	66.1	66.1	65.8	65.8	66.1	66.8
20:30	68.9	68.9	66.4	66.4	65.6	65.5	65.9	66.8
20:45	68.5	68.5	66.2	66.3	65.5	65.6	65.4	66.6
21:00	68.7	68.6	66.0	66.0	65.4	65.4	65.1	66.5
21:15	67.9	67.8	65.4	65.3	65.1	65.0	65.3	66.0
21:30	68.3	68.3	65.4	65.3	64.8	64.7	64.8	65.9
21:45	67.9	67.9	65.1	65.1	64.9	64.9	64.9	65.8
22:00	67.3	67.3	64.9	64.9	64.5	64.6	64.5	65.5
22:15	67.0	67.0	64.9	64.9	64.4	64.5	64.6	65.3
22:30	66.7	66.7	65.0	64.9	64.3	64.3	64.3	65.2
22:45	65.6	65.5	64.2	64.2	63.6	63.6	63.5	64.3
23:00	64.9	64.9	63.8	63.7	63.6	63.6	63.6	64.0
23:15	66.1	66.1	64.5	64.5	63.7	63.7	64.0	64.7
23:30	65.5	65.5	64.5	64.5	63.8	63.8	63.8	64.5
23:45	65.8	65.8	64.0	63.9	63.5	63.6	63.7	64.3
Average Speed	68.7	68.7	64.5	64.6	64.1	64.2	64.6	65.6

Attachment E-3 – Speed Data

Speed by Time and Location – Southbound								
Time	Mile 58.0	Mile 59.0	Mile 60.0	Route Y	Mile 62.0	MO-58	Mile 64.0	Average Speed
00:00	64.3	64.2	64.2	64.2	65.7	65.7	68.2	65.2
00:15	64.2	64.2	64.3	64.4	66.0	66.0	68.3	65.3
00:30	64.0	64.0	64.4	64.4	66.0	66.0	68.4	65.3
00:45	64.4	64.4	64.6	64.6	66.0	66.0	68.4	65.5
01:00	64.2	64.2	64.6	64.6	66.2	66.2	68.9	65.6
01:15	64.3	64.3	64.6	64.6	66.1	66.1	68.7	65.5
01:30	63.6	63.6	63.9	63.9	65.5	65.5	67.5	64.8
01:45	63.3	63.3	63.5	63.5	65.0	65.0	66.8	64.3
02:00	63.2	63.2	63.3	63.4	64.8	64.8	66.9	64.2
02:15	62.8	62.9	62.9	63.0	64.3	64.3	66.3	63.8
02:30	62.4	62.4	62.6	62.7	64.2	64.2	65.9	63.5
02:45	62.2	62.3	62.3	62.3	64.1	64.1	65.4	63.2
03:00	62.3	62.3	62.3	62.3	63.6	63.6	65.0	63.1
03:15	63.0	63.0	63.1	63.1	64.3	64.3	65.5	63.8
03:30	63.5	63.5	64.0	64.0	64.9	64.9	66.1	64.4
03:45	63.7	63.7	64.1	64.1	65.2	65.2	66.4	64.6
04:00	63.9	63.9	64.1	64.1	65.8	65.8	67.3	65.0
04:15	64.2	64.2	64.2	64.2	65.4	65.4	67.6	65.0
04:30	64.9	64.9	65.1	65.1	66.6	66.6	68.2	65.9
04:45	64.4	64.4	64.5	64.5	66.2	66.2	68.0	65.4
05:00	63.8	63.8	63.9	63.9	65.6	65.6	67.6	64.9
05:15	64.2	64.2	64.5	64.5	66.1	66.1	67.7	65.3
05:30	65.1	65.1	65.0	65.0	66.7	66.7	68.1	65.9
05:45	65.9	65.9	65.9	65.9	67.4	67.4	68.4	66.7
06:00	65.9	65.9	66.0	66.0	67.5	67.5	69.1	66.8
06:15	65.4	65.4	65.5	65.5	66.9	66.9	69.0	66.4
06:30	64.4	64.4	65.0	65.0	66.8	66.8	68.5	65.8
06:45	64.7	64.7	65.1	65.1	67.2	67.2	69.0	66.1
07:00	64.7	64.7	65.0	65.0	67.2	67.2	69.4	66.2
07:15	64.4	64.3	64.9	64.8	67.1	67.1	69.6	66.0
07:30	64.7	64.7	65.3	65.2	67.6	67.6	69.9	66.4
07:45	64.0	64.0	64.7	64.6	67.5	67.5	69.9	66.0
08:00	64.2	64.2	64.7	64.7	67.3	67.3	69.7	66.0
08:15	63.8	63.9	64.7	64.7	67.4	67.4	69.4	65.9
08:30	63.8	63.8	64.6	64.6	67.0	67.0	69.2	65.7
08:45	64.3	64.4	64.7	64.8	67.3	67.3	69.8	66.1
09:00	64.3	64.3	65.0	65.1	67.6	67.6	70.0	66.3
09:15	64.1	64.1	64.7	64.7	67.6	67.6	69.9	66.1
09:30	63.7	63.8	64.4	64.5	67.2	67.2	69.5	65.8
09:45	63.4	63.4	64.2	64.2	67.0	67.0	69.1	65.5
10:00	63.7	63.7	64.5	64.5	66.9	66.9	69.6	65.7
10:15	63.5	63.5	64.2	64.2	66.8	66.8	69.2	65.5
10:30	63.7	63.7	64.4	64.4	66.6	66.6	69.1	65.5
10:45	63.5	63.5	64.1	64.2	66.5	66.5	68.9	65.3
11:00	63.6	63.6	64.3	64.3	66.5	66.5	69.0	65.4
11:15	63.6	63.6	64.3	64.3	66.8	66.8	69.3	65.5
11:30	63.8	63.8	64.6	64.5	66.9	66.9	69.4	65.7
11:45	63.8	63.8	64.1	64.1	67.2	67.2	69.2	65.6
12:00	63.7	63.6	64.3	64.3	67.2	67.2	69.6	65.7
12:15	63.9	63.9	64.6	64.7	67.5	67.5	69.5	65.9
12:30	63.6	63.5	64.1	64.1	66.8	66.8	69.3	65.5
12:45	63.5	63.6	64.0	64.1	66.9	66.9	69.3	65.5
13:00	63.8	63.8	64.4	64.4	67.2	67.2	69.7	65.8
13:15	63.7	63.6	64.3	64.2	67.2	67.2	69.4	65.7
13:30	63.3	63.2	64.0	63.9	67.2	67.2	69.7	65.5
13:45	63.6	63.6	64.3	64.3	67.3	67.3	69.7	65.7
14:00	63.6	63.6	64.5	64.5	67.6	67.6	70.0	65.9
14:15	63.2	63.2	63.9	63.8	67.2	67.2	70.1	65.5
14:30	62.9	62.9	63.8	63.8	67.2	67.2	69.9	65.4
14:45	62.5	62.4	63.6	63.5	67.4	67.4	69.9	65.2
15:00	62.0	62.0	63.5	63.4	67.8	67.8	70.2	65.2
15:15	60.2	60.2	61.8	61.8	67.7	67.7	70.5	64.3
15:30	57.4	57.3	60.7	60.6	67.7	67.7	70.7	63.2
15:45	39.5	39.2	50.9	50.7	66.6	66.6	71.0	54.9
16:00	33.7	33.3	48.2	48.0	66.4	66.4	71.3	52.5
16:15	32.2	31.9	47.7	47.5	66.4	66.4	71.0	51.9
16:30	31.1	30.7	47.8	47.5	66.6	66.6	71.3	51.7
16:45	30.5	30.1	47.1	46.9	66.3	66.3	71.0	51.2
17:00	30.9	30.5	47.1	46.8	66.2	66.2	70.9	51.2
17:15	31.2	30.9	47.4	47.3	66.1	66.1	71.1	51.4
17:30	32.8	32.5	47.8	47.7	66.1	66.1	71.0	52.0
17:45	34.8	34.5	47.7	47.5	66.0	66.0	70.6	52.4
18:00	42.9	42.6	51.1	51.0	65.6	65.6	70.5	55.6
18:15	52.1	52.0	56.9	56.8	66.3	66.3	70.5	60.1
18:30	59.0	58.9	61.3	61.3	67.0	67.0	70.6	63.6
18:45	63.1	63.1	63.5	63.4	67.1	67.1	70.0	65.3
19:00	64.3	64.3	64.5	64.4	67.3	67.3	69.7	66.0
19:15	64.4	64.4	64.7	64.7	67.4	67.4	70.1	66.2
19:30	64.0	64.0	64.4	64.4	66.5	66.5	69.7	65.6
19:45	64.1	64.1	64.7	64.7	66.6	66.6	69.4	65.8
20:00	64.6	64.7	65.0	65.0	66.8	66.8	69.0	66.0
20:15	64.4	64.3	64.5	64.5	66.7	66.7	69.0	65.7
20:30	64.5	64.4	64.3	64.3	66.3	66.3	69.2	65.6
20:45	64.0	64.0	64.1	64.1	66.0	66.0	68.8	65.3
21:00	64.0	64.0	64.1	64.1	65.6	65.6	68.3	65.1
21:15	63.6	63.6	64.0	64.0	65.8	65.8	69.0	65.1
21:30	63.6	63.6	63.7	63.7	65.5	65.5	68.1	64.8
21:45	63.8	63.8	63.8	63.8	65.7	65.7	68.6	65.0
22:00	64.4	64.4	63.9	63.9	65.5	65.5	68.3	65.1
22:15	63.4	63.4	63.3	63.3	64.9	64.9	67.7	64.4
22:30	63.3	63.3	63.1	63.1	64.6	64.6	67.3	64.2
22:45	63.2	63.2	63.3	63.3	64.8	64.8	66.9	64.2
23:00	63.5	63.6	63.8	63.8	65.3	65.3	67.5	64.7
23:15	64.2	64.2	64.3	64.3	65.6	65.6	68.1	65.2
23:30	64.6	64.5	64.5	64.4	66.0	66.0	68.3	65.5
23:45	64.8	64.8	64.4	64.4	65.8	65.8	68.1	65.4
Average Speed	60.5	60.4	62.4	62.4	66.4	66.4	69.0	63.9



ATTACHMENT E4: SYNCHRO ANALYSIS

**Attachment E-4 – Synchro Analysis
2020 AM**

**Lanes, Volumes, Timings
1: Harmon Drive & Route 58**

07/10/2020

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	130	752	106	17	1266	42	399	20	18	37	11	54
Future Volume (vph)	130	752	106	17	1266	42	399	20	18	37	11	54
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		0%			-1%			1%			3%	
Storage Length (ft)	90		0	205		135	200		40	130		55
Storage Lanes	1		0	1		0	1		0	1		0
Taper Length (ft)	25			25			25			25		
Lane Util. Factor	1.00	0.95	0.95	1.00	0.91	0.91	1.00	1.00	1.00	1.00	1.00	1.00
Fr't		0.981			0.995			0.929			0.875	
Flt Protected	0.950			0.950			0.950			0.950		
Satd. Flow (prot)	1770	3430	0	1620	5088	0	1761	1691	0	1726	1611	0
Flt Permitted	0.128			0.240			0.366			0.732		
Satd. Flow (perm)	238	3430	0	409	5088	0	678	1691	0	1330	1611	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		18			6			18			55	
Link Speed (mph)		40			40			45			45	
Link Distance (ft)		302			504			437			563	
Travel Time (s)		5.1			8.6			6.6			8.5	
Peak Hour Factor	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Heavy Vehicles (%)	2%	3%	5%	12%	2%	0%	2%	1%	7%	3%	0%	2%
Adj. Flow (vph)	133	767	108	17	1292	43	407	20	18	38	11	55
Shared Lane Traffic (%)												
Lane Group Flow (vph)	133	875	0	17	1335	0	407	38	0	38	66	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(ft)		12			12			12			12	
Link Offset(ft)		0			0			0			0	
Crosswalk Width(ft)		16			16			16			16	
Two way Left Turn Lane												
Headway Factor	1.00	1.00	1.00	0.99	0.99	0.99	1.01	1.01	1.01	1.02	1.02	1.02
Turning Speed (mph)	15		9	15		9	15		9	15		9
Number of Detectors	1	1		1	1		1	1		1	1	
Detector Template	Left	Thru		Left	Thru		Left	Thru		Left	Thru	
Leading Detector (ft)	30	30		30	30		30	30		30	30	
Trailing Detector (ft)	0	0		0	0		0	0		0	0	
Detector 1 Position(ft)	0	0		0	0		0	0		0	0	
Detector 1 Size(ft)	30	30		30	30		30	30		30	30	
Detector 1 Type	Cl+Ex	Cl+Ex		Cl+Ex	Cl+Ex		Cl+Ex	Cl+Ex		Cl+Ex	Cl+Ex	
Detector 1 Channel												
Detector 1 Extend (s)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Detector 1 Queue (s)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Detector 1 Delay (s)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Turn Type	D.P+P	NA		D.P+P	NA		pm+pt	NA		pm+pt	NA	
Protected Phases	1	6		5	2		7	4		3	8	
Permitted Phases	2			6			4			8		
Detector Phase	1	6		5	2		7	4		3	8	
Switch Phase												
Minimum Initial (s)	5.0	10.0		5.0	10.0		5.0	5.0		4.0	5.0	

**Attachment E-4 – Synchro Analysis
2020 AM**

**Lanes, Volumes, Timings
1: Harmon Drive & Route 58**

07/10/2020

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Minimum Split (s)	11.0	15.6		11.0	15.6		11.2	12.0		11.0	12.0	
Total Split (s)	11.0	55.0		11.0	55.0		32.0	24.0		20.0	12.0	
Total Split (%)	10.0%	50.0%		10.0%	50.0%		29.1%	21.8%		18.2%	10.9%	
Maximum Green (s)	5.4	49.4		5.4	49.4		26.2	18.2		14.2	6.2	
Yellow Time (s)	3.6	3.6		3.6	3.6		4.2	4.2		4.2	4.2	
All-Red Time (s)	2.0	2.0		2.0	2.0		1.6	1.6		1.6	1.6	
Lost Time Adjust (s)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Total Lost Time (s)	5.6	5.6		5.6	5.6		5.8	5.8		5.8	5.8	
Lead/Lag	Lead	Lead		Lag	Lag		Lead	Lag		Lead	Lag	
Lead-Lag Optimize?	Yes	Yes		Yes	Yes		Yes	Yes		Yes	Yes	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	4.0		3.0	4.0	
Recall Mode	None	C-Max		None	C-Max		None	None		None	None	
Walk Time (s)		7.0			7.0							
Flash Dont Walk (s)		16.0			21.0							
Pedestrian Calls (#/hr)		0			0							
Act Effect Green (s)	57.9	59.1		61.3	52.2		35.1	26.8		12.1	6.3	
Actuated g/C Ratio	0.53	0.54		0.56	0.47		0.32	0.24		0.11	0.06	
v/c Ratio	0.65	0.47		0.06	0.55		0.87	0.09		0.22	0.46	
Control Delay	36.4	11.5		12.7	22.2		52.8	22.4		29.9	28.4	
Queue Delay	0.0	0.5		0.0	0.0		0.0	0.0		0.0	0.0	
Total Delay	36.4	12.0		12.7	22.2		52.8	22.4		29.9	28.4	
LOS	D	B		B	C		D	C		C	C	
Approach Delay		15.2			22.1			50.2			28.9	
Approach LOS		B			C			D			C	

Intersection Summary

Area Type: Other

Cycle Length: 110

Actuated Cycle Length: 110

Offset: 103 (94%), Referenced to phase 2:EBWB and 6:EBWB, Start of 1st Green

Natural Cycle: 70

Control Type: Actuated-Coordinated

Maximum v/c Ratio: 0.87

Intersection Signal Delay: 24.3

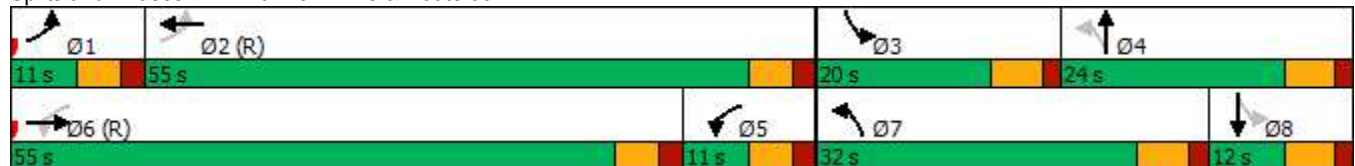
Intersection LOS: C

Intersection Capacity Utilization 75.5%

ICU Level of Service D

Analysis Period (min) 15

Splits and Phases: 1: Harmon Drive & Route 58



**Attachment E-4 – Synchro Analysis
2020 AM**

**Lanes, Volumes, Timings
2: I-49 NB Ramp & Route 58**

07/10/2020

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	260	795	0	0	573	1146	186	0	193	0	0	0
Future Volume (vph)	260	795	0	0	573	1146	186	0	193	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		0%			0%			1%			0%	
Storage Length (ft)	230		0	0		0	331		150	0		0
Storage Lanes	1		0	0		1	0		1	0		0
Taper Length (ft)	150			0			25			0		
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt						0.850			0.850			
Flt Protected	0.950						0.950					
Satd. Flow (prot)	1752	3505	0	0	3539	1599	1761	0	1545	0	0	0
Flt Permitted	0.388						0.950					
Satd. Flow (perm)	716	3505	0	0	3539	1599	1761	0	1545	0	0	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)						760			199			
Link Speed (mph)		40			40			40			40	
Link Distance (ft)		594			302			1066			450	
Travel Time (s)		10.1			5.1			18.2			7.7	
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Heavy Vehicles (%)	3%	3%	0%	0%	2%	1%	2%	0%	4%	0%	0%	0%
Adj. Flow (vph)	268	820	0	0	591	1181	192	0	199	0	0	0
Shared Lane Traffic (%)												
Lane Group Flow (vph)	268	820	0	0	591	1181	192	0	199	0	0	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(ft)		12			12			12			12	
Link Offset(ft)		0			0			0			0	
Crosswalk Width(ft)		16			16			16			16	
Two way Left Turn Lane												
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.01	1.01	1.01	1.00	1.00	1.00
Turning Speed (mph)	15		9	15		9	15		9	15		9
Number of Detectors	1	1			1	1	1		1			
Detector Template	Left	Thru			Thru	Right	Left		Right			
Leading Detector (ft)	30	30			30	30	30		30			
Trailing Detector (ft)	0	0			0	0	0		0			
Detector 1 Position(ft)	0	0			0	0	0		0			
Detector 1 Size(ft)	30	30			30	30	30		30			
Detector 1 Type	Cl+Ex	Cl+Ex			Cl+Ex	Cl+Ex	Cl+Ex		Cl+Ex			
Detector 1 Channel												
Detector 1 Extend (s)	0.0	0.0			0.0	0.0	0.0		0.0			
Detector 1 Queue (s)	0.0	0.0			0.0	0.0	0.0		0.0			
Detector 1 Delay (s)	0.0	0.0			0.0	0.0	0.0		0.0			
Turn Type	D.P+P	NA			NA	Free	Perm		Perm			
Protected Phases	1	6			2							
Permitted Phases	2					Free	7		7			
Detector Phase	1	6			2		7		7			
Switch Phase												
Minimum Initial (s)	5.0	10.0			10.0		8.0		8.0			

**Attachment E-4 – Synchro Analysis
2020 AM**

**Lanes, Volumes, Timings
2: I-49 NB Ramp & Route 58**

07/10/2020

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Minimum Split (s)	12.0	15.3			21.3		15.0		15.0			
Total Split (s)	24.0	84.0			60.0		26.0		26.0			
Total Split (%)	21.8%	76.4%			54.5%		23.6%		23.6%			
Maximum Green (s)	18.7	78.7			54.7		20.1		20.1			
Yellow Time (s)	3.6	3.6			3.6		3.9		3.9			
All-Red Time (s)	1.7	1.7			1.7		2.0		2.0			
Lost Time Adjust (s)	0.0	0.0			0.0		0.0		0.0			
Total Lost Time (s)	5.3	5.3			5.3		5.9		5.9			
Lead/Lag	Lag				Lead							
Lead-Lag Optimize?	Yes				Yes							
Vehicle Extension (s)	3.0	3.0			3.0		3.0		3.0			
Recall Mode	None	C-Max			C-Max		None		None			
Walk Time (s)		7.0			5.0							
Flash Dont Walk (s)		12.0			11.0							
Pedestrian Calls (#/hr)		0			0							
Act Effct Green (s)	77.0	82.3			58.3	110.0	16.5		16.5			
Actuated g/C Ratio	0.70	0.75			0.53	1.00	0.15		0.15			
v/c Ratio	0.40	0.31			0.32	0.74	0.73		0.50			
Control Delay	10.7	5.7			10.2	13.3	60.3		10.1			
Queue Delay	0.0	0.0			0.4	0.0	0.0		0.0			
Total Delay	10.7	5.7			10.6	13.3	60.3		10.1			
LOS	B	A			B	B	E		B			
Approach Delay		6.9			12.4			34.8				
Approach LOS		A			B			C				

Intersection Summary

Area Type: Other

Cycle Length: 110

Actuated Cycle Length: 110

Offset: 7 (6%), Referenced to phase 2:EBWB and 6:EBT, Start of 1st Green

Natural Cycle: 50

Control Type: Actuated-Coordinated

Maximum v/c Ratio: 0.74

Intersection Signal Delay: 13.3

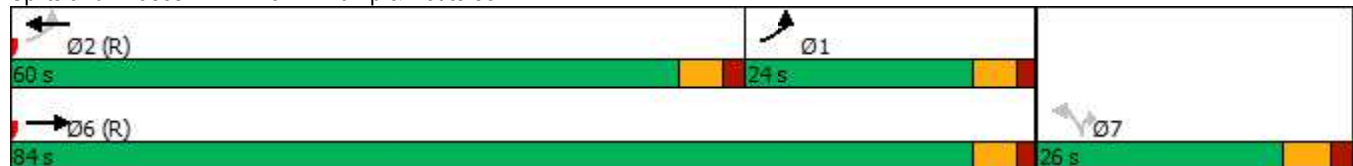
Intersection LOS: B

Intersection Capacity Utilization 54.3%

ICU Level of Service A

Analysis Period (min) 15

Splits and Phases: 2: I-49 NB Ramp & Route 58



**Attachment E-4 – Synchro Analysis
2020 AM**

Lanes, Volumes, Timings
3: I-49 SB Ramp & Route 58

07/10/2020

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	648	110	74	685	0	0	0	0	408	0	159
Future Volume (vph)	0	648	110	74	685	0	0	0	0	408	0	159
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		1%			0%			0%			2%	
Storage Length (ft)	0		0	140		0	0		0	0		350
Storage Lanes	0		0	1		0	0		0	2		1
Taper Length (ft)	0			150			0			0		
Lane Util. Factor	1.00	0.95	0.95	1.00	0.95	1.00	1.00	1.00	1.00	0.97	1.00	1.00
Frt		0.978										0.850
Flt Protected				0.950						0.950		
Satd. Flow (prot)	0	3401	0	1752	3539	0	0	0	0	3366	0	1552
Flt Permitted				0.291						0.950		
Satd. Flow (perm)	0	3401	0	537	3539	0	0	0	0	3366	0	1552
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		22										166
Link Speed (mph)		40			40			40			40	
Link Distance (ft)		315			594			338			1067	
Travel Time (s)		5.4			10.1			5.8			18.2	
Peak Hour Factor	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Heavy Vehicles (%)	0%	3%	5%	3%	2%	0%	0%	0%	0%	3%	0%	3%
Adj. Flow (vph)	0	675	115	77	714	0	0	0	0	425	0	166
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	790	0	77	714	0	0	0	0	425	0	166
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(ft)		12			12			24			24	
Link Offset(ft)		0			0			0			0	
Crosswalk Width(ft)		16			16			16			16	
Two way Left Turn Lane												
Headway Factor	1.01	1.01	1.01	1.00	1.00	1.00	1.00	1.00	1.00	1.01	1.01	1.01
Turning Speed (mph)	15		9	15		9	15		9	15		9
Number of Detectors		1		1	1					1		1
Detector Template		Thru		Left	Thru					Left		Right
Leading Detector (ft)		30		30	30					30		30
Trailing Detector (ft)		0		0	0					0		0
Detector 1 Position(ft)		0		0	0					0		0
Detector 1 Size(ft)		30		30	30					30		30
Detector 1 Type		Cl+Ex		Cl+Ex	Cl+Ex					Cl+Ex		Cl+Ex
Detector 1 Channel												
Detector 1 Extend (s)		0.0		0.0	0.0					0.0		0.0
Detector 1 Queue (s)		0.0		0.0	0.0					0.0		0.0
Detector 1 Delay (s)		0.0		0.0	0.0					0.0		0.0
Turn Type		NA		D,P+P	NA					Prot		Prot
Protected Phases		6		5	2					3		3
Permitted Phases				6								
Detector Phase		6		5	2					3		3
Switch Phase												
Minimum Initial (s)		10.0		6.0	10.0					8.0		8.0

**Attachment E-4 – Synchro Analysis
2020 AM**

**Lanes, Volumes, Timings
3: I-49 SB Ramp & Route 58**

07/10/2020

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Minimum Split (s)		21.6		12.0	21.6					15.0		15.0
Total Split (s)		52.0		20.0	72.0					38.0		38.0
Total Split (%)		47.3%		18.2%	65.5%					34.5%		34.5%
Maximum Green (s)		46.4		14.4	66.4					32.1		32.1
Yellow Time (s)		3.6		3.6	3.6					3.9		3.9
All-Red Time (s)		2.0		2.0	2.0					2.0		2.0
Lost Time Adjust (s)		0.0		0.0	0.0					0.0		0.0
Total Lost Time (s)		5.6		5.6	5.6					5.9		5.9
Lead/Lag		Lead		Lag								
Lead-Lag Optimize?		Yes		Yes								
Vehicle Extension (s)		5.0		5.0	3.0					6.0		6.0
Recall Mode		C-Max		None	C-Max					None		None
Walk Time (s)		7.0			7.0							
Flash Dont Walk (s)		21.0			10.0							
Pedestrian Calls (#/hr)		0			0							
Act Effect Green (s)		58.9		70.4	74.9					23.6		23.6
Actuated g/C Ratio		0.54		0.64	0.68					0.21		0.21
v/c Ratio		0.43		0.16	0.30					0.59		0.36
Control Delay		8.9		4.8	4.0					41.7		7.2
Queue Delay		0.2		0.0	0.0					0.0		0.0
Total Delay		9.1		4.8	4.0					41.7		7.2
LOS		A		A	A					D		A
Approach Delay		9.1			4.1						32.0	
Approach LOS		A			A						C	

Intersection Summary

Area Type: Other

Cycle Length: 110

Actuated Cycle Length: 110

Offset: 16 (15%), Referenced to phase 2:WBT and 6:EBWB, Start of 1st Green

Natural Cycle: 50

Control Type: Actuated-Coordinated

Maximum v/c Ratio: 0.59

Intersection Signal Delay: 13.5

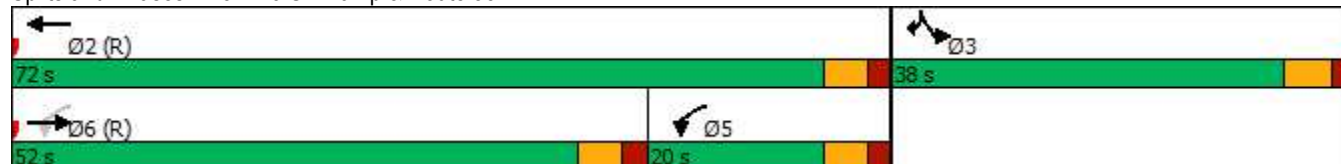
Intersection LOS: B

Intersection Capacity Utilization 54.3%

ICU Level of Service A

Analysis Period (min) 15

Splits and Phases: 3: I-49 SB Ramp & Route 58



**Attachment E-4 – Synchro Analysis
2020 AM**

**Lanes, Volumes, Timings
4: Peculiar Dr & Route 58**

07/10/2020

						
Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↑↑		↓	↑↑	↓	
Traffic Volume (vph)	544	1	48	797	49	213
Future Volume (vph)	544	1	48	797	49	213
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Grade (%)	2%			-1%	2%	
Storage Length (ft)		0	140		307	60
Storage Lanes		0	1		0	0
Taper Length (ft)			25		25	
Lane Util. Factor	0.95	0.95	1.00	0.95	1.00	1.00
Frt					0.890	
Flt Protected			0.950		0.991	
Satd. Flow (prot)	3470	0	1744	3557	1550	0
Flt Permitted			0.390		0.991	
Satd. Flow (perm)	3470	0	716	3557	1550	0
Right Turn on Red		Yes				Yes
Satd. Flow (RTOR)					199	
Link Speed (mph)	40			40	45	
Link Distance (ft)	881			315	346	
Travel Time (s)	15.0			5.4	5.2	
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89
Heavy Vehicles (%)	3%	0%	4%	2%	3%	8%
Adj. Flow (vph)	611	1	54	896	55	239
Shared Lane Traffic (%)						
Lane Group Flow (vph)	612	0	54	896	294	0
Enter Blocked Intersection	No	No	No	No	No	No
Lane Alignment	Left	Right	Left	Left	Left	Right
Median Width(ft)	12			12	12	
Link Offset(ft)	0			0	0	
Crosswalk Width(ft)	16			16	16	
Two way Left Turn Lane						
Headway Factor	1.01	1.01	0.99	0.99	1.01	1.01
Turning Speed (mph)		9	15		15	9
Number of Detectors	1		1	1	1	
Detector Template	Thru		Left	Thru	Left	
Leading Detector (ft)	30		30	30	30	
Trailing Detector (ft)	0		0	0	0	
Detector 1 Position(ft)	0		0	0	0	
Detector 1 Size(ft)	30		30	30	30	
Detector 1 Type	Cl+Ex		Cl+Ex	Cl+Ex	Cl+Ex	
Detector 1 Channel						
Detector 1 Extend (s)	0.0		0.0	0.0	0.0	
Detector 1 Queue (s)	0.0		0.0	0.0	0.0	
Detector 1 Delay (s)	0.0		0.0	0.0	0.0	
Turn Type	NA		D.P+P	NA	Prot	
Protected Phases	6		5	2	7	
Permitted Phases			6			
Detector Phase	6		5	2	7	
Switch Phase						
Minimum Initial (s)	10.0		6.0	10.0	8.0	

Lanes, Volumes, Timings
4: Peculiar Dr & Route 58

07/10/2020

	→	↘	↙	←	↖	↗
Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Minimum Split (s)	21.1		11.1	21.1	15.0	
Total Split (s)	49.0		24.0	73.0	37.0	
Total Split (%)	44.5%		21.8%	66.4%	33.6%	
Maximum Green (s)	43.9		18.9	67.9	31.5	
Yellow Time (s)	3.6		3.6	3.6	3.6	
All-Red Time (s)	1.5		1.5	1.5	1.9	
Lost Time Adjust (s)	0.0		0.0	0.0	0.0	
Total Lost Time (s)	5.1		5.1	5.1	5.5	
Lead/Lag	Lead		Lag			
Lead-Lag Optimize?	Yes		Yes			
Vehicle Extension (s)	3.0		3.0	3.0	3.0	
Recall Mode	C-Max		None	C-Max	None	
Walk Time (s)	7.0					
Flash Dont Walk (s)	11.0					
Pedestrian Calls (#/hr)	0					
Act Effect Green (s)	66.1		81.2	85.3	14.1	
Actuated g/C Ratio	0.60		0.74	0.78	0.13	
v/c Ratio	0.29		0.08	0.32	0.79	
Control Delay	13.4		2.0	1.8	30.5	
Queue Delay	0.0		0.0	0.2	0.0	
Total Delay	13.4		2.0	2.0	30.5	
LOS	B		A	A	C	
Approach Delay	13.4			2.0	30.5	
Approach LOS	B			A	C	

Intersection Summary

Area Type: Other

Cycle Length: 110

Actuated Cycle Length: 110

Offset: 25 (23%), Referenced to phase 2:WBT and 6:EBWB, Start of 1st Green

Natural Cycle: 50

Control Type: Actuated-Coordinated

Maximum v/c Ratio: 0.79

Intersection Signal Delay: 10.3

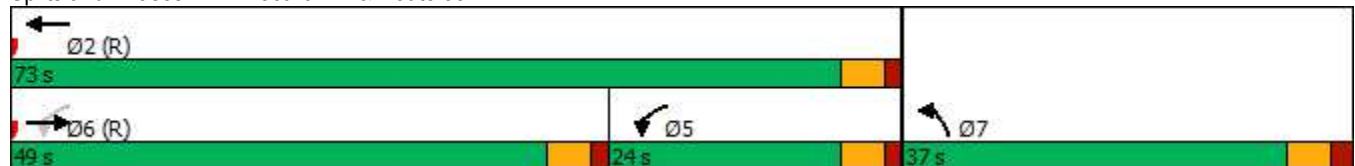
Intersection LOS: B

Intersection Capacity Utilization 49.0%

ICU Level of Service A

Analysis Period (min) 15

Splits and Phases: 4: Peculiar Dr & Route 58



**Attachment E-4 – Synchro Analysis
2020 AM**

Lanes, Volumes, Timings

30: I-49 SB Ramp & N. Cass Parkway

07/10/2020

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑↑↑	↑	↑	↑↑					↑↑		↑
Traffic Volume (vph)	0	103	30	149	141	0	0	0	0	50	0	16
Future Volume (vph)	0	103	30	149	141	0	0	0	0	50	0	16
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	60		290	0		0	0		0	380		380
Storage Lanes	1		1	1		0	0		0	1		1
Taper Length (ft)	25			0			0			25		
Lane Util. Factor	1.00	0.91	1.00	1.00	0.95	1.00	1.00	1.00	1.00	0.97	1.00	1.00
Frt			0.850									0.850
Flt Protected				0.950						0.950		
Satd. Flow (prot)	0	5085	1583	1770	3539	0	0	0	0	3433	0	1583
Flt Permitted				0.484						0.950		
Satd. Flow (perm)	0	5085	1583	902	3539	0	0	0	0	3433	0	1583
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)			149									160
Link Speed (mph)		45			45			40			40	
Link Distance (ft)		607			634			565			826	
Travel Time (s)		9.2			9.6			9.6			14.1	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	112	33	162	153	0	0	0	0	54	0	17
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	112	33	162	153	0	0	0	0	54	0	17
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(ft)		12			12			24			24	
Link Offset(ft)		0			0			0			0	
Crosswalk Width(ft)		16			16			16			16	
Two way Left Turn Lane												
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Turning Speed (mph)	15		9	15		9	15		9	15		9
Number of Detectors		2	1	1	2					1		1
Detector Template		Thru	Right	Left	Thru					Left		Right
Leading Detector (ft)		100	20	20	100					20		20
Trailing Detector (ft)		0	0	0	0					0		0
Detector 1 Position(ft)		0	0	0	0					0		0
Detector 1 Size(ft)		6	20	20	6					20		20
Detector 1 Type		Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex					Cl+Ex		Cl+Ex
Detector 1 Channel												
Detector 1 Extend (s)		0.0	0.0	0.0	0.0					0.0		0.0
Detector 1 Queue (s)		0.0	0.0	0.0	0.0					0.0		0.0
Detector 1 Delay (s)		0.0	0.0	0.0	0.0					0.0		0.0
Detector 2 Position(ft)		94			94							
Detector 2 Size(ft)		6			6							
Detector 2 Type		Cl+Ex			Cl+Ex							
Detector 2 Channel												
Detector 2 Extend (s)		0.0			0.0							
Turn Type		NA	Perm	pm+pt	NA					Prot		Perm
Protected Phases		4		3	8					5		
Permitted Phases			4	8								5

**Attachment E-4 – Synchro Analysis
2020 AM**

Lanes, Volumes, Timings

30: I-49 SB Ramp & N. Cass Parkway

07/10/2020

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Detector Phase		4	4	3	8					5		5
Switch Phase												
Minimum Initial (s)		10.0	10.0	7.0	10.0					7.0		7.0
Minimum Split (s)		21.6	21.6	12.5	21.2					12.7		12.7
Total Split (s)		30.0	30.0	15.0	45.0					15.0		15.0
Total Split (%)		50.0%	50.0%	25.0%	75.0%					25.0%		25.0%
Maximum Green (s)		23.7	23.7	9.5	39.8					9.3		9.3
Yellow Time (s)		4.8	4.8	4.1	4.1					4.0		4.0
All-Red Time (s)		1.5	1.5	1.4	1.1					1.7		1.7
Lost Time Adjust (s)		0.0	0.0	0.0	0.0					0.0		0.0
Total Lost Time (s)		6.3	6.3	5.5	5.2					5.7		5.7
Lead/Lag		Lag	Lag	Lead								
Lead-Lag Optimize?		Yes	Yes	Yes								
Vehicle Extension (s)		3.0	3.0	3.0	3.0					3.0		3.0
Recall Mode		Min	Min	None	Min					None		None
Act Effect Green (s)		13.8	13.8	19.3	16.2					34.9		34.9
Actuated g/C Ratio		0.23	0.23	0.32	0.27					0.58		0.58
v/c Ratio		0.10	0.07	0.38	0.16					0.03		0.02
Control Delay		19.5	0.3	29.5	14.1					11.6		0.1
Queue Delay		0.0	0.0	0.0	0.0					0.0		0.0
Total Delay		19.5	0.3	29.5	14.1					11.6		0.1
LOS		B	A	C	B					B		A
Approach Delay		15.1			22.0						8.8	
Approach LOS		B			C						A	

Intersection Summary

Area Type: Other

Cycle Length: 60

Actuated Cycle Length: 60

Offset: 0 (0%), Referenced to phase 2: and 6:, Start of Green

Natural Cycle: 50

Control Type: Actuated-Coordinated

Maximum v/c Ratio: 0.38

Intersection Signal Delay: 18.3

Intersection LOS: B

Intersection Capacity Utilization 37.0%

ICU Level of Service A

Analysis Period (min) 15

Splits and Phases: 30: I-49 SB Ramp & N. Cass Parkway



**Attachment E-4 – Synchro Analysis
2020 AM**

Lanes, Volumes, Timings

33: I-49 NB Ramp & N. Cass Parkway

07/10/2020

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		 			  							
Traffic Volume (vph)	76	78	0	0	211	278	80	0	116	0	0	0
Future Volume (vph)	76	78	0	0	211	278	80	0	116	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0		0	60		320	285		285	0		0
Storage Lanes	1		0	1		1	0		1	0		0
Taper Length (ft)	0			25			25			0		
Lane Util. Factor	1.00	0.95	1.00	1.00	0.91	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt						0.850			0.850			
Flt Protected	0.950						0.950					
Satd. Flow (prot)	1770	3539	0	0	5085	1583	1770	0	1583	0	0	0
Flt Permitted	0.320						0.950					
Satd. Flow (perm)	596	3539	0	0	5085	1583	1770	0	1583	0	0	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)						302			156			
Link Speed (mph)		45			45			40			40	
Link Distance (ft)		634			604			748			707	
Travel Time (s)		9.6			9.2			12.8			12.1	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	83	85	0	0	229	302	87	0	126	0	0	0
Shared Lane Traffic (%)												
Lane Group Flow (vph)	83	85	0	0	229	302	87	0	126	0	0	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(ft)		12			12			12			12	
Link Offset(ft)		0			0			0			0	
Crosswalk Width(ft)		16			0			16			16	
Two way Left Turn Lane												
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Turning Speed (mph)	15		9	15		9	15		9	15		9
Number of Detectors	1	2			2	1	1		1			
Detector Template	Left	Thru			Thru	Right	Left		Right			
Leading Detector (ft)	20	100			100	20	20		20			
Trailing Detector (ft)	0	0			0	0	0		0			
Detector 1 Position(ft)	0	0			0	0	0		0			
Detector 1 Size(ft)	20	6			6	20	20		20			
Detector 1 Type	Cl+Ex	Cl+Ex			Cl+Ex	Cl+Ex	Cl+Ex		Cl+Ex			
Detector 1 Channel												
Detector 1 Extend (s)	0.0	0.0			0.0	0.0	0.0		0.0			
Detector 1 Queue (s)	0.0	0.0			0.0	0.0	0.0		0.0			
Detector 1 Delay (s)	0.0	0.0			0.0	0.0	0.0		0.0			
Detector 2 Position(ft)		94			94							
Detector 2 Size(ft)		6			6							
Detector 2 Type		Cl+Ex			Cl+Ex							
Detector 2 Channel												
Detector 2 Extend (s)		0.0			0.0							
Turn Type	pm+pt	NA			NA	Free	Prot		Perm			
Protected Phases	3	8			4		5					
Permitted Phases	8					Free			5			

**Attachment E-4 – Synchro Analysis
2020 AM**

Lanes, Volumes, Timings

33: I-49 NB Ramp & N. Cass Parkway

07/10/2020

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Detector Phase	3	8			4		5		5			
Switch Phase												
Minimum Initial (s)	7.0	10.0			10.0		7.0		7.0			
Minimum Split (s)	13.1	20.0			20.0		12.4		12.4			
Total Split (s)	15.0	45.0			30.0		15.0		15.0			
Total Split (%)	25.0%	75.0%			50.0%		25.0%		25.0%			
Maximum Green (s)	8.9	39.5			24.6		9.6		9.6			
Yellow Time (s)	4.5	4.5			4.0		4.0		4.0			
All-Red Time (s)	1.6	1.0			1.4		1.4		1.4			
Lost Time Adjust (s)	0.0	0.0			0.0		0.0		0.0			
Total Lost Time (s)	6.1	5.5			5.4		5.4		5.4			
Lead/Lag	Lead				Lag							
Lead-Lag Optimize?	Yes				Yes							
Vehicle Extension (s)	3.0	3.0			3.0		3.0		3.0			
Recall Mode	None	Min			Min		None		None			
Act Effct Green (s)	17.4	16.5			8.0	60.0	33.7		33.7			
Actuated g/C Ratio	0.29	0.28			0.13	1.00	0.56		0.56			
v/c Ratio	0.26	0.09			0.34	0.19	0.09		0.13			
Control Delay	32.0	27.9			23.4	0.3	10.6		2.0			
Queue Delay	0.0	0.0			0.0	0.0	0.0		0.0			
Total Delay	32.0	27.9			23.4	0.3	10.6		2.0			
LOS	C	C			C	A	B		A			
Approach Delay		30.0			10.2			5.5				
Approach LOS		C			B			A				

Intersection Summary

Area Type: Other

Cycle Length: 60

Actuated Cycle Length: 60

Offset: 0 (0%), Referenced to phase 2: and 6:, Start of Green

Natural Cycle: 50

Control Type: Actuated-Coordinated

Maximum v/c Ratio: 0.34

Intersection Signal Delay: 12.8

Intersection LOS: B

Intersection Capacity Utilization 37.0%

ICU Level of Service A

Analysis Period (min) 15

Splits and Phases: 33: I-49 NB Ramp & N. Cass Parkway



**Attachment E-4 – Synchro Analysis
2020 AM**

Lanes, Volumes, Timings

65: I-49 NB Ramp & 163rd St./163rd St

07/10/2020

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	661	319	0	0	683	611	212	0	159	0	0	0
Future Volume (vph)	661	319	0	0	683	611	212	0	159	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0		0	255		520	0		135	0		0
Storage Lanes	2		0	1		1	1		1	0		0
Taper Length (ft)	0			100			0			0		
Lane Util. Factor	0.97	0.95	1.00	1.00	0.91	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt						0.850			0.850			
Flt Protected	0.950						0.950					
Satd. Flow (prot)	3433	3539	0	0	5085	1583	1770	0	1583	0	0	0
Flt Permitted	0.950						0.950					
Satd. Flow (perm)	3433	3539	0	0	5085	1583	1770	0	1583	0	0	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)						580			212			
Link Speed (mph)		35			35			40			40	
Link Distance (ft)		335			638			916			594	
Travel Time (s)		6.5			12.4			15.6			10.1	
Peak Hour Factor	0.76	0.84	0.92	0.92	0.71	0.91	0.75	0.92	0.75	0.92	0.92	0.92
Adj. Flow (vph)	870	380	0	0	962	671	283	0	212	0	0	0
Shared Lane Traffic (%)												
Lane Group Flow (vph)	870	380	0	0	962	671	283	0	212	0	0	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Right	Right	Right	Left	Left	Right	Left	Left	Right
Median Width(ft)		24			24			12			12	
Link Offset(ft)		0			0			0			0	
Crosswalk Width(ft)		16			16			16			16	
Two way Left Turn Lane												
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Turning Speed (mph)	15		9	15		9	15		9	15		9
Number of Detectors	1	1			1	1	1		1			
Detector Template	Left	Thru			Thru	Right	Left		Right			
Leading Detector (ft)	30	30			30	30	30		30			
Trailing Detector (ft)	0	0			0	0	0		0			
Detector 1 Position(ft)	0	0			0	0	0		0			
Detector 1 Size(ft)	30	30			30	30	30		30			
Detector 1 Type	Cl+Ex	Cl+Ex			Cl+Ex	Cl+Ex	Cl+Ex		Cl+Ex			
Detector 1 Channel												
Detector 1 Extend (s)	0.0	0.0			0.0	0.0	0.0		0.0			
Detector 1 Queue (s)	0.0	0.0			0.0	0.0	0.0		0.0			
Detector 1 Delay (s)	0.0	0.0			0.0	0.0	0.0		0.0			
Turn Type	Prot	NA			NA	Perm	Prot		Perm			
Protected Phases	1	1 2			2		3					
Permitted Phases						2			3			
Detector Phase	1	1 2			2	2	3		3			
Switch Phase												
Minimum Initial (s)	6.0				12.0	12.0	6.0		6.0			
Minimum Split (s)	11.8				17.8	17.8	12.8		12.8			
Total Split (s)	21.0				35.0	35.0	24.0		24.0			

Scenario 1 5:00 pm 10/08/2019 Baseline

Synchro 11 Report
Page 13

Lanes, Volumes, Timings

65: I-49 NB Ramp & 163rd St./163rd St

07/10/2020

Lane Group	Ø5	Ø6	Ø7
Lane Configurations			
Traffic Volume (vph)			
Future Volume (vph)			
Ideal Flow (vphpl)			
Storage Length (ft)			
Storage Lanes			
Taper Length (ft)			
Lane Util. Factor			
Frt			
Flt Protected			
Satd. Flow (prot)			
Flt Permitted			
Satd. Flow (perm)			
Right Turn on Red			
Satd. Flow (RTOR)			
Link Speed (mph)			
Link Distance (ft)			
Travel Time (s)			
Peak Hour Factor			
Adj. Flow (vph)			
Shared Lane Traffic (%)			
Lane Group Flow (vph)			
Enter Blocked Intersection			
Lane Alignment			
Median Width(ft)			
Link Offset(ft)			
Crosswalk Width(ft)			
Two way Left Turn Lane			
Headway Factor			
Turning Speed (mph)			
Number of Detectors			
Detector Template			
Leading Detector (ft)			
Trailing Detector (ft)			
Detector 1 Position(ft)			
Detector 1 Size(ft)			
Detector 1 Type			
Detector 1 Channel			
Detector 1 Extend (s)			
Detector 1 Queue (s)			
Detector 1 Delay (s)			
Turn Type			
Protected Phases	5	6	7
Permitted Phases			
Detector Phase			
Switch Phase			
Minimum Initial (s)	10.0	12.0	6.0
Minimum Split (s)	15.7	17.7	12.8
Total Split (s)	18.0	38.0	24.0

**Attachment E-4 – Synchro Analysis
2020 AM**

Lanes, Volumes, Timings

65: I-49 NB Ramp & 163rd St./163rd St

07/10/2020

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Total Split (%)	26.3%				43.8%	43.8%	30.0%		30.0%			
Maximum Green (s)	15.2				29.2	29.2	17.2		17.2			
Yellow Time (s)	3.6				3.6	3.6	3.6		3.6			
All-Red Time (s)	2.2				2.2	2.2	3.2		3.2			
Lost Time Adjust (s)	0.0				0.0	0.0	0.0		0.0			
Total Lost Time (s)	5.8				5.8	5.8	6.8		6.8			
Lead/Lag	Lag				Lead	Lead						
Lead-Lag Optimize?	Yes				Yes	Yes						
Vehicle Extension (s)	4.0				4.0	4.0	4.0		4.0			
Recall Mode	None				C-Min	C-Min	None		None			
Act Effct Green (s)	16.8	51.2			28.6	28.6	16.2		16.2			
Actuated g/C Ratio	0.21	0.64			0.36	0.36	0.20		0.20			
v/c Ratio	1.21	0.17			0.53	0.71	0.79		0.43			
Control Delay	135.5	5.7			21.5	8.4	47.3		7.2			
Queue Delay	0.0	0.0			0.0	0.0	0.0		0.0			
Total Delay	135.5	5.7			21.5	8.4	47.3		7.2			
LOS	F	A			C	A	D		A			
Approach Delay		96.0			16.1			30.1				
Approach LOS		F			B			C				

Intersection Summary

Area Type: Other

Cycle Length: 80

Actuated Cycle Length: 80

Offset: 47 (59%), Referenced to phase 2:EBWB and 6:, Start of 1st Green

Natural Cycle: 70

Control Type: Actuated-Coordinated

Maximum v/c Ratio: 1.21

Intersection Signal Delay: 47.7

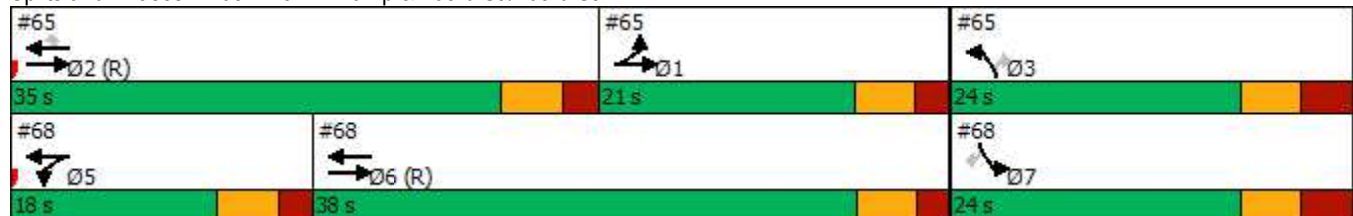
Intersection LOS: D

Intersection Capacity Utilization 83.8%

ICU Level of Service E

Analysis Period (min) 15

Splits and Phases: 65: I-49 NB Ramp & 163rd St./163rd St



Lanes, Volumes, Timings

65: I-49 NB Ramp & 163rd St./163rd St

07/10/2020

Lane Group	Ø5	Ø6	Ø7
Total Split (%)	23%	48%	30%
Maximum Green (s)	12.3	32.3	17.2
Yellow Time (s)	3.6	3.6	3.6
All-Red Time (s)	2.1	2.1	3.2
Lost Time Adjust (s)			
Total Lost Time (s)			
Lead/Lag	Lead	Lag	
Lead-Lag Optimize?	Yes	Yes	
Vehicle Extension (s)	4.0	4.0	4.0
Recall Mode	None	C-Min	None
Act Effect Green (s)			
Actuated g/C Ratio			
v/c Ratio			
Control Delay			
Queue Delay			
Total Delay			
LOS			
Approach Delay			
Approach LOS			
Intersection Summary			

**Attachment E-4 – Synchro Analysis
2020 AM**

Lanes, Volumes, Timings

68: I-49 SB Ramp & 163rd St/163rd St.

07/10/2020

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	682	34	86	810	0	0	0	0	297	0	318
Future Volume (vph)	0	682	34	86	810	0	0	0	0	297	0	318
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	390		0	0		0	0		0	285		340
Storage Lanes	2		0	1		0	0		0	1		1
Taper Length (ft)	110			0			0			120		
Lane Util. Factor	1.00	0.86	0.86	1.00	0.95	1.00	1.00	1.00	1.00	0.97	1.00	1.00
Frt		0.993										0.850
Flt Protected				0.950						0.950		
Satd. Flow (prot)	0	6363	0	1770	3539	0	0	0	0	3433	0	1583
Flt Permitted				0.950						0.950		
Satd. Flow (perm)	0	6363	0	1770	3539	0	0	0	0	3433	0	1583
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		15										195
Link Speed (mph)		35			35			40			40	
Link Distance (ft)		628			335			662			1293	
Travel Time (s)		12.2			6.5			11.3			22.0	
Peak Hour Factor	0.92	0.79	0.78	0.60	0.78	0.92	0.92	0.92	0.92	0.91	0.92	0.89
Adj. Flow (vph)	0	863	44	143	1038	0	0	0	0	326	0	357
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	907	0	143	1038	0	0	0	0	326	0	357
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Right	Left	Right
Median Width(ft)		20			20			24			24	
Link Offset(ft)		0			0			0			0	
Crosswalk Width(ft)		16			16			16			16	
Two way Left Turn Lane												
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Turning Speed (mph)	15		9	15		9	15		9	15		9
Number of Detectors		1		1	1					1		1
Detector Template		Thru		Left	Thru					Left		Right
Leading Detector (ft)		30		30	30					30		30
Trailing Detector (ft)		0		0	0					0		0
Detector 1 Position(ft)		0		0	0					0		0
Detector 1 Size(ft)		30		30	30					30		30
Detector 1 Type		Cl+Ex		Cl+Ex	Cl+Ex					Cl+Ex		Cl+Ex
Detector 1 Channel												
Detector 1 Extend (s)		0.0		0.0	0.0					0.0		0.0
Detector 1 Queue (s)		0.0		0.0	0.0					0.0		0.0
Detector 1 Delay (s)		0.0		0.0	0.0					0.0		0.0
Turn Type		NA		Prot	NA					Prot		Perm
Protected Phases		6		5	5 6					7		
Permitted Phases												7
Detector Phase		6		5	5 6					7		7
Switch Phase												
Minimum Initial (s)		12.0		10.0						6.0		6.0
Minimum Split (s)		17.7		15.7						12.8		12.8
Total Split (s)		38.0		18.0						24.0		24.0

Lanes, Volumes, Timings

68: I-49 SB Ramp & 163rd St/163rd St.

07/10/2020

Lane Group	Ø1	Ø2	Ø3
Lane Configurations			
Traffic Volume (vph)			
Future Volume (vph)			
Ideal Flow (vphpl)			
Storage Length (ft)			
Storage Lanes			
Taper Length (ft)			
Lane Util. Factor			
Frt			
Flt Protected			
Satd. Flow (prot)			
Flt Permitted			
Satd. Flow (perm)			
Right Turn on Red			
Satd. Flow (RTOR)			
Link Speed (mph)			
Link Distance (ft)			
Travel Time (s)			
Peak Hour Factor			
Adj. Flow (vph)			
Shared Lane Traffic (%)			
Lane Group Flow (vph)			
Enter Blocked Intersection			
Lane Alignment			
Median Width(ft)			
Link Offset(ft)			
Crosswalk Width(ft)			
Two way Left Turn Lane			
Headway Factor			
Turning Speed (mph)			
Number of Detectors			
Detector Template			
Leading Detector (ft)			
Trailing Detector (ft)			
Detector 1 Position(ft)			
Detector 1 Size(ft)			
Detector 1 Type			
Detector 1 Channel			
Detector 1 Extend (s)			
Detector 1 Queue (s)			
Detector 1 Delay (s)			
Turn Type			
Protected Phases	1	2	3
Permitted Phases			
Detector Phase			
Switch Phase			
Minimum Initial (s)	6.0	12.0	6.0
Minimum Split (s)	11.8	17.8	12.8
Total Split (s)	21.0	35.0	24.0

**Attachment E-4 – Synchro Analysis
2020 AM**

Lanes, Volumes, Timings

68: I-49 SB Ramp & 163rd St/163rd St.

07/10/2020

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Total Split (%)		47.5%		22.5%						30.0%		30.0%
Maximum Green (s)		32.3		12.3						17.2		17.2
Yellow Time (s)		3.6		3.6						3.6		3.6
All-Red Time (s)		2.1		2.1						3.2		3.2
Lost Time Adjust (s)		0.0		0.0						0.0		0.0
Total Lost Time (s)		5.7		5.7						6.8		6.8
Lead/Lag		Lag		Lead								
Lead-Lag Optimize?		Yes		Yes								
Vehicle Extension (s)		4.0		4.0						4.0		4.0
Recall Mode		C-Min		None						None		None
Act Effect Green (s)		32.5		13.0	51.3					16.2		16.2
Actuated g/C Ratio		0.41		0.16	0.64					0.20		0.20
v/c Ratio		0.35		0.50	0.46					0.47		0.75
Control Delay		16.6		38.2	4.3					30.3		24.2
Queue Delay		0.0		0.0	0.4					0.0		0.0
Total Delay		16.6		38.2	4.7					30.3		24.2
LOS		B		D	A					C		C
Approach Delay		16.6			8.8						27.1	
Approach LOS		B			A						C	

Intersection Summary

Area Type: Other

Cycle Length: 80

Actuated Cycle Length: 80

Offset: 47 (59%), Referenced to phase 2:EBWB and 6:, Start of 1st Green

Natural Cycle: 70

Control Type: Actuated-Coordinated

Maximum v/c Ratio: 1.21

Intersection Signal Delay: 15.9

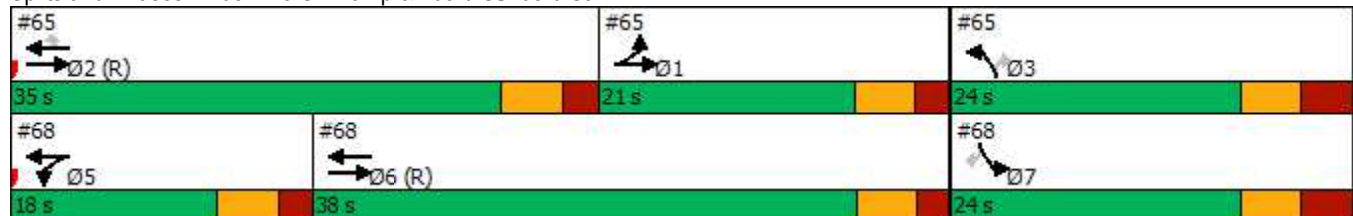
Intersection LOS: B

Intersection Capacity Utilization 83.8%

ICU Level of Service E

Analysis Period (min) 15

Splits and Phases: 68: I-49 SB Ramp & 163rd St/163rd St.



Lanes, Volumes, Timings

68: I-49 SB Ramp & 163rd St/163rd St.

07/10/2020

Lane Group	Ø1	Ø2	Ø3
Total Split (%)	26%	44%	30%
Maximum Green (s)	15.2	29.2	17.2
Yellow Time (s)	3.6	3.6	3.6
All-Red Time (s)	2.2	2.2	3.2
Lost Time Adjust (s)			
Total Lost Time (s)			
Lead/Lag	Lag	Lead	
Lead-Lag Optimize?	Yes	Yes	
Vehicle Extension (s)	4.0	4.0	4.0
Recall Mode	None	C-Min	None
Act Effect Green (s)			
Actuated g/C Ratio			
v/c Ratio			
Control Delay			
Queue Delay			
Total Delay			
LOS			
Approach Delay			
Approach LOS			
Intersection Summary			

**Attachment E-4 – Synchro Analysis
2020 PM**

**Lanes, Volumes, Timings
1: Harmon Drive & Route 58**

07/10/2020

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	39	1717	355	10	1356	52	188	27	29	67	28	103
Future Volume (vph)	39	1717	355	10	1356	52	188	27	29	67	28	103
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		0%			-1%			1%			3%	
Storage Length (ft)	90		0	205		135	200		40	130		55
Storage Lanes	1		0	1		0	1		0	1		0
Taper Length (ft)	25			25			25			25		
Lane Util. Factor	1.00	0.95	0.95	1.00	0.91	0.91	1.00	1.00	1.00	1.00	1.00	1.00
Frt		0.974			0.994			0.921			0.882	
Flt Protected	0.950			0.950			0.950			0.950		
Satd. Flow (prot)	1752	3487	0	1814	5128	0	1796	1741	0	1778	1638	0
Flt Permitted	0.138			0.042			0.315			0.719		
Satd. Flow (perm)	255	3487	0	80	5128	0	596	1741	0	1346	1638	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		37			9			30			100	
Link Speed (mph)		40			40			45			45	
Link Distance (ft)		302			504			454			563	
Travel Time (s)		5.1			8.6			6.9			8.5	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Heavy Vehicles (%)	3%	1%	0%	0%	1%	2%	0%	0%	0%	0%	0%	1%
Adj. Flow (vph)	41	1807	374	11	1427	55	198	28	31	71	29	108
Shared Lane Traffic (%)												
Lane Group Flow (vph)	41	2181	0	11	1482	0	198	59	0	71	137	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(ft)		12			12			12			12	
Link Offset(ft)		0			0			0			0	
Crosswalk Width(ft)		16			16			16			16	
Two way Left Turn Lane												
Headway Factor	1.00	1.00	1.00	0.99	0.99	0.99	1.01	1.01	1.01	1.02	1.02	1.02
Turning Speed (mph)	15		9	15		9	15		9	15		9
Number of Detectors	1	1		1	1		1	1		1	1	
Detector Template	Left	Thru		Left	Thru		Left	Thru		Left	Thru	
Leading Detector (ft)	30	30		30	30		30	30		30	30	
Trailing Detector (ft)	0	0		0	0		0	0		0	0	
Detector 1 Position(ft)	0	0		0	0		0	0		0	0	
Detector 1 Size(ft)	30	30		30	30		30	30		30	30	
Detector 1 Type	Cl+Ex	Cl+Ex		Cl+Ex	Cl+Ex		Cl+Ex	Cl+Ex		Cl+Ex	Cl+Ex	
Detector 1 Channel												
Detector 1 Extend (s)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Detector 1 Queue (s)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Detector 1 Delay (s)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Turn Type	D.P+P	NA		D.P+P	NA		pm+pt	NA		pm+pt	NA	
Protected Phases	1	6		5	2		7	4		3	8	
Permitted Phases	2			6			4			8		
Detector Phase	1	6		5	2		7	4		3	8	
Switch Phase												
Minimum Initial (s)	5.0	10.0		5.0	10.0		5.0	5.0		4.0	5.0	

**Attachment E-4 – Synchro Analysis
2020 PM**

**Lanes, Volumes, Timings
1: Harmon Drive & Route 58**

07/10/2020

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Minimum Split (s)	11.0	15.6		11.0	15.6		11.2	12.0		11.0	12.0	
Total Split (s)	11.0	98.0		11.0	98.0		19.0	15.0		16.0	12.0	
Total Split (%)	7.9%	70.0%		7.9%	70.0%		13.6%	10.7%		11.4%	8.6%	
Maximum Green (s)	5.4	92.4		5.4	92.4		13.2	9.2		10.2	6.2	
Yellow Time (s)	3.6	3.6		3.6	3.6		4.2	4.2		4.2	4.2	
All-Red Time (s)	2.0	2.0		2.0	2.0		1.6	1.6		1.6	1.6	
Lost Time Adjust (s)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Total Lost Time (s)	5.6	5.6		5.6	5.6		5.8	5.8		5.8	5.8	
Lead/Lag	Lead	Lead		Lag	Lag		Lead	Lag		Lead	Lag	
Lead-Lag Optimize?	Yes	Yes		Yes	Yes		Yes	Yes		Yes	Yes	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	4.0		3.0	4.0	
Recall Mode	None	C-Max		None	C-Max		None	None		None	None	
Walk Time (s)		7.0			7.0							
Flash Dont Walk (s)		16.0			21.0							
Pedestrian Calls (#/hr)		0			0							
Act Effect Green (s)	98.9	99.0		101.2	94.6		23.3	12.7		15.4	6.2	
Actuated g/C Ratio	0.71	0.71		0.72	0.68		0.17	0.09		0.11	0.04	
v/c Ratio	0.17	0.88		0.09	0.43		0.93	0.32		0.40	0.82	
Control Delay	4.2	17.6		8.6	11.0		100.8	40.1		56.7	55.0	
Queue Delay	0.0	1.1		0.0	0.0		0.0	0.0		0.0	0.0	
Total Delay	4.2	18.8		8.6	11.0		100.8	40.1		56.7	55.0	
LOS	A	B		A	B		F	D		E	D	
Approach Delay		18.5			11.0			86.9			55.6	
Approach LOS		B			B			F			E	

Intersection Summary

Area Type: Other

Cycle Length: 140

Actuated Cycle Length: 140

Offset: 112 (80%), Referenced to phase 2:EBWB and 6:EBWB, Start of 1st Green

Natural Cycle: 110

Control Type: Actuated-Coordinated

Maximum v/c Ratio: 0.93

Intersection Signal Delay: 21.9

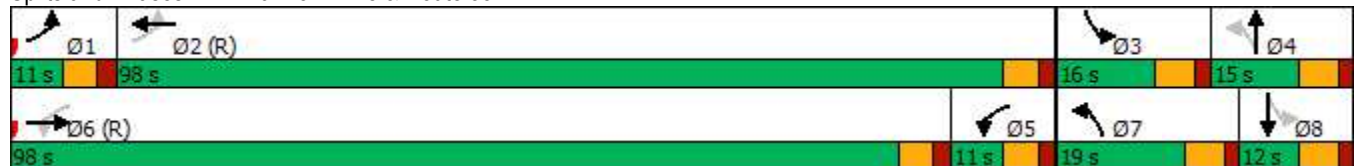
Intersection LOS: C

Intersection Capacity Utilization 91.4%

ICU Level of Service F

Analysis Period (min) 15

Splits and Phases: 1: Harmon Drive & Route 58



**Attachment E-4 – Synchro Analysis
2020 PM**

**Lanes, Volumes, Timings
2: I-49 NB Ramp & Route 58**

07/10/2020

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		 			 							
Traffic Volume (vph)	175	1974	0	0	957	690	140	0	138	0	0	0
Future Volume (vph)	175	1974	0	0	957	690	140	0	138	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		0%			0%			1%			0%	
Storage Length (ft)	230		0	0		0	331		150	0		0
Storage Lanes	1		0	0		1	0		1	0		0
Taper Length (ft)	150			0			25			0		
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt						0.850			0.850			
Flt Protected	0.950						0.950					
Satd. Flow (prot)	1805	3574	0	0	3574	1599	1744	0	1591	0	0	0
Flt Permitted	0.254						0.950					
Satd. Flow (perm)	483	3574	0	0	3574	1599	1744	0	1591	0	0	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)						387			59			
Link Speed (mph)		40			40			40			40	
Link Distance (ft)		594			302			1074			450	
Travel Time (s)		10.1			5.1			18.3			7.7	
Peak Hour Factor	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Heavy Vehicles (%)	0%	1%	0%	0%	1%	1%	3%	0%	1%	0%	0%	0%
Adj. Flow (vph)	182	2056	0	0	997	719	146	0	144	0	0	0
Shared Lane Traffic (%)												
Lane Group Flow (vph)	182	2056	0	0	997	719	146	0	144	0	0	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(ft)		12			12			12			12	
Link Offset(ft)		0			0			0			0	
Crosswalk Width(ft)		16			16			16			16	
Two way Left Turn Lane												
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.01	1.01	1.01	1.00	1.00	1.00
Turning Speed (mph)	15		9	15		9	15		9	15		9
Number of Detectors	1	1			1	1	1		1			
Detector Template	Left	Thru			Thru	Right	Left		Right			
Leading Detector (ft)	30	30			30	30	30		30			
Trailing Detector (ft)	0	0			0	0	0		0			
Detector 1 Position(ft)	0	0			0	0	0		0			
Detector 1 Size(ft)	30	30			30	30	30		30			
Detector 1 Type	Cl+Ex	Cl+Ex			Cl+Ex	Cl+Ex	Cl+Ex		Cl+Ex			
Detector 1 Channel												
Detector 1 Extend (s)	0.0	0.0			0.0	0.0	0.0		0.0			
Detector 1 Queue (s)	0.0	0.0			0.0	0.0	0.0		0.0			
Detector 1 Delay (s)	0.0	0.0			0.0	0.0	0.0		0.0			
Turn Type	D.P+P	NA			NA	Free	Perm		Perm			
Protected Phases	1	6			2							
Permitted Phases	2					Free	7		7			
Detector Phase	1	6			2		7		7			
Switch Phase												
Minimum Initial (s)	5.0	10.0			10.0		8.0		8.0			

**Attachment E-4 – Synchro Analysis
2020 PM**

**Lanes, Volumes, Timings
2: I-49 NB Ramp & Route 58**

07/10/2020

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Minimum Split (s)	12.0	15.3			21.3		15.0		15.0			
Total Split (s)	17.0	116.0			99.0		24.0		24.0			
Total Split (%)	12.1%	82.9%			70.7%		17.1%		17.1%			
Maximum Green (s)	11.7	110.7			93.7		18.1		18.1			
Yellow Time (s)	3.6	3.6			3.6		3.9		3.9			
All-Red Time (s)	1.7	1.7			1.7		2.0		2.0			
Lost Time Adjust (s)	0.0	0.0			0.0		0.0		0.0			
Total Lost Time (s)	5.3	5.3			5.3		5.9		5.9			
Lead/Lag	Lead				Lag							
Lead-Lag Optimize?	Yes				Yes							
Vehicle Extension (s)	3.0	3.0			3.0		3.0		3.0			
Recall Mode	None	C-Max			C-Max		None		None			
Walk Time (s)					5.0							
Flash Dont Walk (s)					11.0							
Pedestrian Calls (#/hr)					0							
Act Effct Green (s)	107.9	113.2			99.2	140.0	15.6		15.6			
Actuated g/C Ratio	0.77	0.81			0.71	1.00	0.11		0.11			
v/c Ratio	0.40	0.71			0.39	0.45	0.75		0.63			
Control Delay	5.2	6.4			6.6	2.3	83.2		46.7			
Queue Delay	0.0	1.1			0.2	0.0	0.0		0.3			
Total Delay	5.2	7.5			6.8	2.3	83.2		47.0			
LOS	A	A			A	A	F		D			
Approach Delay	7.3				4.9				65.2			
Approach LOS	A				A				E			

Intersection Summary

Area Type: Other

Cycle Length: 140

Actuated Cycle Length: 140

Offset: 90 (64%), Referenced to phase 2:EBWB and 6:EBT, Start of 1st Green

Natural Cycle: 60

Control Type: Actuated-Coordinated

Maximum v/c Ratio: 0.75

Intersection Signal Delay: 10.3

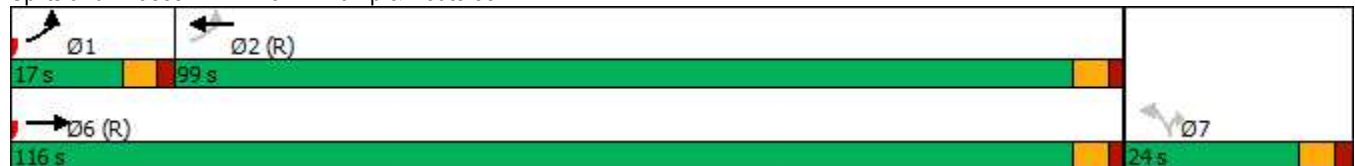
Intersection LOS: B

Intersection Capacity Utilization 109.6%

ICU Level of Service H

Analysis Period (min) 15

Splits and Phases: 2: I-49 NB Ramp & Route 58



**Attachment E-4 – Synchro Analysis
2020 PM**

**Lanes, Volumes, Timings
3: I-49 SB Ramp & Route 58**

07/10/2020

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	1072	276	141	956	0	0	0	0	1077	0	254
Future Volume (vph)	0	1072	276	141	956	0	0	0	0	1077	0	254
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		1%			0%			0%			2%	
Storage Length (ft)	0		0	140		0	0		0	0		350
Storage Lanes	0		0	1		0	0		0	2		1
Taper Length (ft)	0			150			0			0		
Lane Util. Factor	1.00	0.95	0.95	1.00	0.95	1.00	1.00	1.00	1.00	0.97	1.00	1.00
Frt		0.969										0.850
Flt Protected				0.950						0.950		
Satd. Flow (prot)	0	3466	0	1770	3574	0	0	0	0	3432	0	1567
Flt Permitted				0.073						0.950		
Satd. Flow (perm)	0	3466	0	136	3574	0	0	0	0	3432	0	1567
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		27										86
Link Speed (mph)		40			40			40			40	
Link Distance (ft)		315			594			338			1066	
Travel Time (s)		5.4			10.1			5.8			18.2	
Peak Hour Factor	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Heavy Vehicles (%)	0%	0%	2%	2%	1%	0%	0%	0%	0%	1%	0%	2%
Adj. Flow (vph)	0	1094	282	144	976	0	0	0	0	1099	0	259
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	1376	0	144	976	0	0	0	0	1099	0	259
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(ft)		12			12			24			24	
Link Offset(ft)		0			0			0			0	
Crosswalk Width(ft)		16			16			16			16	
Two way Left Turn Lane												
Headway Factor	1.01	1.01	1.01	1.00	1.00	1.00	1.00	1.00	1.00	1.01	1.01	1.01
Turning Speed (mph)	15		9	15		9	15		9	15		9
Number of Detectors		1		1	1					1		1
Detector Template		Thru		Left	Thru					Left		Right
Leading Detector (ft)		30		30	30					30		30
Trailing Detector (ft)		0		0	0					0		0
Detector 1 Position(ft)		0		0	0					0		0
Detector 1 Size(ft)		30		30	30					30		30
Detector 1 Type		Cl+Ex		Cl+Ex	Cl+Ex					Cl+Ex		Cl+Ex
Detector 1 Channel												
Detector 1 Extend (s)		0.0		0.0	0.0					0.0		0.0
Detector 1 Queue (s)		0.0		0.0	0.0					0.0		0.0
Detector 1 Delay (s)		0.0		0.0	0.0					0.0		0.0
Turn Type		NA		D,P+P	NA					Prot		Prot
Protected Phases		6		5	2					3		3
Permitted Phases				6								
Detector Phase		6		5	2					3		3
Switch Phase												
Minimum Initial (s)		10.0		6.0	10.0					8.0		8.0

**Attachment E-4 – Synchro Analysis
2020 PM**

**Lanes, Volumes, Timings
3: I-49 SB Ramp & Route 58**

07/10/2020

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Minimum Split (s)		21.6		12.0	21.6					15.0		15.0
Total Split (s)		59.0		18.0	77.0					63.0		63.0
Total Split (%)		42.1%		12.9%	55.0%					45.0%		45.0%
Maximum Green (s)		53.4		12.4	71.4					57.1		57.1
Yellow Time (s)		3.6		3.6	3.6					3.9		3.9
All-Red Time (s)		2.0		2.0	2.0					2.0		2.0
Lost Time Adjust (s)		0.0		0.0	0.0					0.0		0.0
Total Lost Time (s)		5.6		5.6	5.6					5.9		5.9
Lead/Lag		Lead		Lag								
Lead-Lag Optimize?		Yes		Yes								
Vehicle Extension (s)		5.0		5.0	3.0					6.0		6.0
Recall Mode		C-Max		None	C-Max					None		None
Walk Time (s)		7.0			7.0							
Flash Dont Walk (s)		21.0			10.0							
Pedestrian Calls (#/hr)		0			0							
Act Effect Green (s)		54.8		67.2	72.8					55.7		55.7
Actuated g/C Ratio		0.39		0.48	0.52					0.40		0.40
v/c Ratio		1.00		0.69	0.53					0.81		0.38
Control Delay		49.6		69.5	27.5					42.7		20.9
Queue Delay		5.2		0.0	0.8					0.0		0.0
Total Delay		54.8		69.5	28.3					42.7		20.9
LOS		D		E	C					D		C
Approach Delay		54.8			33.6						38.5	
Approach LOS		D			C						D	

Intersection Summary

Area Type: Other

Cycle Length: 140

Actuated Cycle Length: 140

Offset: 25 (18%), Referenced to phase 2:WBT and 6:EBWB, Start of 1st Green

Natural Cycle: 90

Control Type: Actuated-Coordinated

Maximum v/c Ratio: 1.00

Intersection Signal Delay: 42.9

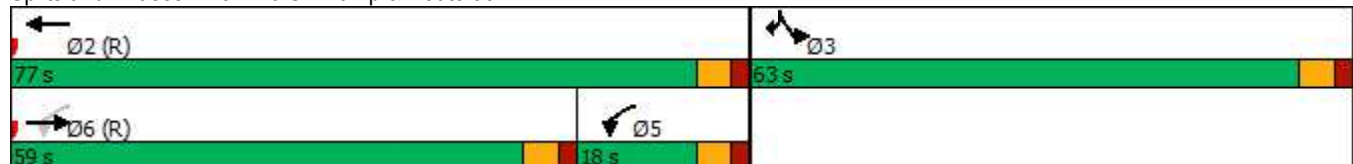
Intersection LOS: D

Intersection Capacity Utilization 109.6%

ICU Level of Service H

Analysis Period (min) 15

Splits and Phases: 3: I-49 SB Ramp & Route 58



**Attachment E-4 – Synchro Analysis
2020 PM**

**Lanes, Volumes, Timings
4: Peculiar Dr & Route 58**

07/10/2020

						
Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↑↑		↓	↑↑	↓	
Traffic Volume (vph)	1278	39	74	1137	28	69
Future Volume (vph)	1278	39	74	1137	28	69
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Grade (%)	2%			-1%	2%	
Storage Length (ft)		0	140		307	60
Storage Lanes		0	1		0	0
Taper Length (ft)			25		25	
Lane Util. Factor	0.95	0.95	1.00	0.95	1.00	1.00
Frt	0.996				0.903	
Flt Protected			0.950		0.986	
Satd. Flow (prot)	3525	0	1814	3592	1651	0
Flt Permitted			0.127		0.986	
Satd. Flow (perm)	3525	0	243	3592	1651	0
Right Turn on Red		Yes				Yes
Satd. Flow (RTOR)	3				73	
Link Speed (mph)	40			40	45	
Link Distance (ft)	881			315	346	
Travel Time (s)	15.0			5.4	5.2	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Heavy Vehicles (%)	1%	0%	0%	1%	0%	2%
Adj. Flow (vph)	1345	41	78	1197	29	73
Shared Lane Traffic (%)						
Lane Group Flow (vph)	1386	0	78	1197	102	0
Enter Blocked Intersection	No	No	No	No	No	No
Lane Alignment	Left	Right	Left	Left	Left	Right
Median Width(ft)	12			12	12	
Link Offset(ft)	0			0	0	
Crosswalk Width(ft)	16			16	16	
Two way Left Turn Lane						
Headway Factor	1.01	1.01	0.99	0.99	1.01	1.01
Turning Speed (mph)		9	15		15	9
Number of Detectors	1		1	1	1	
Detector Template	Thru		Left	Thru	Left	
Leading Detector (ft)	30		30	30	30	
Trailing Detector (ft)	0		0	0	0	
Detector 1 Position(ft)	0		0	0	0	
Detector 1 Size(ft)	30		30	30	30	
Detector 1 Type	Cl+Ex		Cl+Ex	Cl+Ex	Cl+Ex	
Detector 1 Channel						
Detector 1 Extend (s)	0.0		0.0	0.0	0.0	
Detector 1 Queue (s)	0.0		0.0	0.0	0.0	
Detector 1 Delay (s)	0.0		0.0	0.0	0.0	
Turn Type	NA		D.P+P	NA	Prot	
Protected Phases	6		5	2	7	
Permitted Phases			6			
Detector Phase	6		5	2	7	
Switch Phase						
Minimum Initial (s)	10.0		6.0	10.0	8.0	

**Attachment E-4 – Synchro Analysis
2020 PM**

**Lanes, Volumes, Timings
4: Peculiar Dr & Route 58**

07/10/2020

	→	↘	↙	←	↖	↗
Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Minimum Split (s)	21.1		11.1	21.1	15.0	
Total Split (s)	70.0		32.0	102.0	38.0	
Total Split (%)	50.0%		22.9%	72.9%	27.1%	
Maximum Green (s)	64.9		26.9	96.9	32.5	
Yellow Time (s)	3.6		3.6	3.6	3.6	
All-Red Time (s)	1.5		1.5	1.5	1.9	
Lost Time Adjust (s)	0.0		0.0	0.0	0.0	
Total Lost Time (s)	5.1		5.1	5.1	5.5	
Lead/Lag	Lead		Lag			
Lead-Lag Optimize?	Yes		Yes			
Vehicle Extension (s)	3.0		3.0	3.0	3.0	
Recall Mode	C-Max		None	C-Max	None	
Walk Time (s)	7.0					
Flash Dont Walk (s)	11.0					
Pedestrian Calls (#/hr)	0					
Act Effect Green (s)	87.8		114.7	119.8	9.6	
Actuated g/C Ratio	0.63		0.82	0.86	0.07	
v/c Ratio	0.63		0.16	0.39	0.56	
Control Delay	17.9		3.9	1.2	34.0	
Queue Delay	3.7		0.0	0.1	0.1	
Total Delay	21.6		3.9	1.3	34.1	
LOS	C		A	A	C	
Approach Delay	21.6			1.5	34.1	
Approach LOS	C			A	C	

Intersection Summary

Area Type: Other

Cycle Length: 140

Actuated Cycle Length: 140

Offset: 19 (14%), Referenced to phase 2:WBT and 6:EBWB, Start of 1st Green

Natural Cycle: 60

Control Type: Actuated-Coordinated

Maximum v/c Ratio: 0.63

Intersection Signal Delay: 12.8

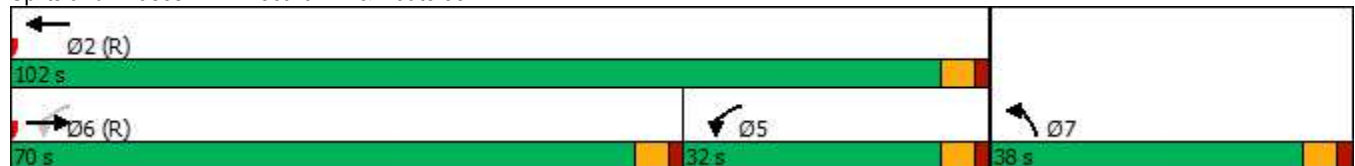
Intersection LOS: B

Intersection Capacity Utilization 61.3%

ICU Level of Service B

Analysis Period (min) 15

Splits and Phases: 4: Peculiar Dr & Route 58



**Attachment E-4 – Synchro Analysis
2020 PM**

Lanes, Volumes, Timings

30: I-49 SB Ramp & N. Cass Parkway

07/10/2020

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑↑↑	↑	↑	↑↑					↑↑		↑
Traffic Volume (vph)	0	105	69	187	168	0	0	0	0	161	0	101
Future Volume (vph)	0	105	69	187	168	0	0	0	0	161	0	101
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	60		290	0		0	0		0	380		380
Storage Lanes	1		1	1		0	0		0	1		1
Taper Length (ft)	25			0			0			25		
Lane Util. Factor	1.00	0.91	1.00	1.00	0.95	1.00	1.00	1.00	1.00	0.97	1.00	1.00
Frt			0.850									0.850
Flt Protected				0.950						0.950		
Satd. Flow (prot)	0	5085	1583	1770	3539	0	0	0	0	3433	0	1583
Flt Permitted				0.514						0.950		
Satd. Flow (perm)	0	5085	1583	957	3539	0	0	0	0	3433	0	1583
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)			149									160
Link Speed (mph)		45			45			40			40	
Link Distance (ft)		607			634			565			826	
Travel Time (s)		9.2			9.6			9.6			14.1	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	114	75	203	183	0	0	0	0	175	0	110
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	114	75	203	183	0	0	0	0	175	0	110
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(ft)		12			12			24			24	
Link Offset(ft)		0			0			0			0	
Crosswalk Width(ft)		16			16			16			16	
Two way Left Turn Lane												
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Turning Speed (mph)	15		9	15		9	15		9	15		9
Number of Detectors		2	1	1	2					1		1
Detector Template		Thru	Right	Left	Thru					Left		Right
Leading Detector (ft)		100	20	20	100					20		20
Trailing Detector (ft)		0	0	0	0					0		0
Detector 1 Position(ft)		0	0	0	0					0		0
Detector 1 Size(ft)		6	20	20	6					20		20
Detector 1 Type		Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex					Cl+Ex		Cl+Ex
Detector 1 Channel												
Detector 1 Extend (s)		0.0	0.0	0.0	0.0					0.0		0.0
Detector 1 Queue (s)		0.0	0.0	0.0	0.0					0.0		0.0
Detector 1 Delay (s)		0.0	0.0	0.0	0.0					0.0		0.0
Detector 2 Position(ft)		94			94							
Detector 2 Size(ft)		6			6							
Detector 2 Type		Cl+Ex			Cl+Ex							
Detector 2 Channel												
Detector 2 Extend (s)		0.0			0.0							
Turn Type		NA	Perm	pm+pt	NA					Prot		Perm
Protected Phases		4		3	8					5		
Permitted Phases			4	8								5

**Attachment E-4 – Synchro Analysis
2020 PM**

Lanes, Volumes, Timings

30: I-49 SB Ramp & N. Cass Parkway

07/10/2020

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Detector Phase		4	4	3	8					5		5
Switch Phase												
Minimum Initial (s)		10.0	10.0	7.0	10.0					7.0		7.0
Minimum Split (s)		21.6	21.6	12.5	21.2					12.7		12.7
Total Split (s)		30.0	30.0	15.0	45.0					15.0		15.0
Total Split (%)		50.0%	50.0%	25.0%	75.0%					25.0%		25.0%
Maximum Green (s)		23.7	23.7	9.5	39.8					9.3		9.3
Yellow Time (s)		4.8	4.8	4.1	4.1					4.0		4.0
All-Red Time (s)		1.5	1.5	1.4	1.1					1.7		1.7
Lost Time Adjust (s)		0.0	0.0	0.0	0.0					0.0		0.0
Total Lost Time (s)		6.3	6.3	5.5	5.2					5.7		5.7
Lead/Lag		Lag	Lag	Lead								
Lead-Lag Optimize?		Yes	Yes	Yes								
Vehicle Extension (s)		3.0	3.0	3.0	3.0					3.0		3.0
Recall Mode		Min	Min	None	Min					None		None
Act Effect Green (s)		16.3	16.3	22.2	21.0					29.1		29.1
Actuated g/C Ratio		0.27	0.27	0.37	0.35					0.48		0.48
v/c Ratio		0.08	0.14	0.42	0.15					0.11		0.13
Control Delay		21.4	1.2	26.1	10.6					11.9		1.5
Queue Delay		0.0	0.0	0.0	0.0					0.0		0.0
Total Delay		21.4	1.2	26.1	10.6					11.9		1.5
LOS		C	A	C	B					B		A
Approach Delay		13.4			18.8						7.9	
Approach LOS		B			B						A	

Intersection Summary

Area Type: Other

Cycle Length: 60

Actuated Cycle Length: 60

Offset: 0 (0%), Referenced to phase 2: and 6:, Start of Green

Natural Cycle: 50

Control Type: Actuated-Coordinated

Maximum v/c Ratio: 0.42

Intersection Signal Delay: 14.0

Intersection LOS: B

Intersection Capacity Utilization 39.1%

ICU Level of Service A

Analysis Period (min) 15

Splits and Phases: 30: I-49 SB Ramp & N. Cass Parkway



**Attachment E-4 – Synchro Analysis
2020 PM**

Lanes, Volumes, Timings

33: I-49 NB Ramp & N. Cass Parkway

07/10/2020

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		 			  							
Traffic Volume (vph)	64	202	0	0	289	278	65	0	149	0	0	0
Future Volume (vph)	64	202	0	0	289	278	65	0	149	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0		0	60		320	285		285	0		0
Storage Lanes	1		0	1		1	0		1	0		0
Taper Length (ft)	0			25			25			0		
Lane Util. Factor	1.00	0.95	1.00	1.00	0.91	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt						0.850			0.850			
Flt Protected	0.950						0.950					
Satd. Flow (prot)	1770	3539	0	0	5085	1583	1770	0	1583	0	0	0
Flt Permitted	0.303						0.950					
Satd. Flow (perm)	564	3539	0	0	5085	1583	1770	0	1583	0	0	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)						302			162			
Link Speed (mph)		45			45			40			40	
Link Distance (ft)		634			604			748			707	
Travel Time (s)		9.6			9.2			12.8			12.1	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	70	220	0	0	314	302	71	0	162	0	0	0
Shared Lane Traffic (%)												
Lane Group Flow (vph)	70	220	0	0	314	302	71	0	162	0	0	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(ft)		12			12			12			12	
Link Offset(ft)		0			0			0			0	
Crosswalk Width(ft)		16			0			16			16	
Two way Left Turn Lane												
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Turning Speed (mph)	15		9	15		9	15		9	15		9
Number of Detectors	1	2			2	1	1		1			
Detector Template	Left	Thru			Thru	Right	Left		Right			
Leading Detector (ft)	20	100			100	20	20		20			
Trailing Detector (ft)	0	0			0	0	0		0			
Detector 1 Position(ft)	0	0			0	0	0		0			
Detector 1 Size(ft)	20	6			6	20	20		20			
Detector 1 Type	Cl+Ex	Cl+Ex			Cl+Ex	Cl+Ex	Cl+Ex		Cl+Ex			
Detector 1 Channel												
Detector 1 Extend (s)	0.0	0.0			0.0	0.0	0.0		0.0			
Detector 1 Queue (s)	0.0	0.0			0.0	0.0	0.0		0.0			
Detector 1 Delay (s)	0.0	0.0			0.0	0.0	0.0		0.0			
Detector 2 Position(ft)		94			94							
Detector 2 Size(ft)		6			6							
Detector 2 Type		Cl+Ex			Cl+Ex							
Detector 2 Channel												
Detector 2 Extend (s)		0.0			0.0							
Turn Type	pm+pt	NA			NA	Free	Prot		Perm			
Protected Phases	3	8			4		5					
Permitted Phases	8					Free			5			

**Attachment E-4 – Synchro Analysis
2020 PM**

Lanes, Volumes, Timings

33: I-49 NB Ramp & N. Cass Parkway

07/10/2020

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Detector Phase	3	8			4		5		5			
Switch Phase												
Minimum Initial (s)	7.0	10.0			10.0		7.0		7.0			
Minimum Split (s)	13.1	20.0			20.0		12.4		12.4			
Total Split (s)	15.0	45.0			30.0		15.0		15.0			
Total Split (%)	25.0%	75.0%			50.0%		25.0%		25.0%			
Maximum Green (s)	8.9	39.5			24.6		9.6		9.6			
Yellow Time (s)	4.5	4.5			4.0		4.0		4.0			
All-Red Time (s)	1.6	1.0			1.4		1.4		1.4			
Lost Time Adjust (s)	0.0	0.0			0.0		0.0		0.0			
Total Lost Time (s)	6.1	5.5			5.4		5.4		5.4			
Lead/Lag	Lead				Lag							
Lead-Lag Optimize?	Yes				Yes							
Vehicle Extension (s)	3.0	3.0			3.0		3.0		3.0			
Recall Mode	None	Min			Min		None		None			
Act Effct Green (s)	17.4	16.5			8.2	60.0	33.7		33.7			
Actuated g/C Ratio	0.29	0.28			0.14	1.00	0.56		0.56			
v/c Ratio	0.22	0.23			0.45	0.19	0.07		0.17			
Control Delay	24.4	22.2			24.3	0.3	10.7		3.0			
Queue Delay	0.0	0.0			0.0	0.0	0.0		0.0			
Total Delay	24.4	22.2			24.3	0.3	10.7		3.0			
LOS	C	C			C	A	B		A			
Approach Delay		22.8			12.5			5.3				
Approach LOS		C			B			A				

Intersection Summary

Area Type: Other

Cycle Length: 60

Actuated Cycle Length: 60

Offset: 0 (0%), Referenced to phase 2: and 6:, Start of Green

Natural Cycle: 50

Control Type: Actuated-Coordinated

Maximum v/c Ratio: 0.45

Intersection Signal Delay: 13.6

Intersection LOS: B

Intersection Capacity Utilization 39.1%

ICU Level of Service A

Analysis Period (min) 15

Splits and Phases: 33: I-49 NB Ramp & N. Cass Parkway



**Attachment E-4 – Synchro Analysis
2020 PM**

Lanes, Volumes, Timings
65: I-49 NB Ramp & 163rd St

07/10/2020

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰↰	↱↱			↰↰↰	↱	↰		↱			
Traffic Volume (vph)	574	770	0	0	459	247	148	0	97	0	0	0
Future Volume (vph)	574	770	0	0	459	247	148	0	97	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0		0	255		520	0		135	0		0
Storage Lanes	2		0	1		1	1		1	0		0
Taper Length (ft)	0			100			0			0		
Lane Util. Factor	0.97	0.95	1.00	1.00	0.91	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt						0.850			0.850			
Flt Protected	0.950						0.950					
Satd. Flow (prot)	3433	3539	0	0	5085	1583	1770	0	1583	0	0	0
Flt Permitted	0.950						0.950					
Satd. Flow (perm)	3433	3539	0	0	5085	1583	1770	0	1583	0	0	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)						287			248			
Link Speed (mph)		35			35			40			40	
Link Distance (ft)		335			765			393			376	
Travel Time (s)		6.5			14.9			6.7			6.4	
Peak Hour Factor	0.90	0.93	0.92	0.92	0.90	0.86	0.83	0.92	0.82	0.92	0.92	0.92
Adj. Flow (vph)	638	828	0	0	510	287	178	0	118	0	0	0
Shared Lane Traffic (%)												
Lane Group Flow (vph)	638	828	0	0	510	287	178	0	118	0	0	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(ft)		24			24			12			12	
Link Offset(ft)		0			0			0			0	
Crosswalk Width(ft)		16			16			16			16	
Two way Left Turn Lane												
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Turning Speed (mph)	15		9	15		9	15		9	15		9
Number of Detectors	1	1			1	1	1		1			
Detector Template	Left	Thru			Thru	Right	Left		Right			
Leading Detector (ft)	30	30			30	30	30		30			
Trailing Detector (ft)	0	0			0	0	0		0			
Detector 1 Position(ft)	0	0			0	0	0		0			
Detector 1 Size(ft)	30	30			30	30	30		30			
Detector 1 Type	Cl+Ex	Cl+Ex			Cl+Ex	Cl+Ex	Cl+Ex		Cl+Ex			
Detector 1 Channel												
Detector 1 Extend (s)	0.0	0.0			0.0	0.0	0.0		0.0			
Detector 1 Queue (s)	0.0	0.0			0.0	0.0	0.0		0.0			
Detector 1 Delay (s)	0.0	0.0			0.0	0.0	0.0		0.0			
Turn Type	Prot	NA			NA	Perm	Prot		Perm			
Protected Phases	1 4	1 2 4			2		3					
Permitted Phases						2			3			
Detector Phase	1	1 2			2	2	3		3			
Switch Phase												
Minimum Initial (s)					12.0	12.0	6.0		6.0			
Minimum Split (s)					17.6	17.6	12.8		12.8			
Total Split (s)					31.0	31.0	25.0		25.0			

Lanes, Volumes, Timings
65: I-49 NB Ramp & 163rd St

07/10/2020

Lane Group	Ø1	Ø4	Ø5	Ø6	Ø7
Lane Configurations					
Traffic Volume (vph)					
Future Volume (vph)					
Ideal Flow (vphpl)					
Storage Length (ft)					
Storage Lanes					
Taper Length (ft)					
Lane Util. Factor					
Frt					
Flt Protected					
Satd. Flow (prot)					
Flt Permitted					
Satd. Flow (perm)					
Right Turn on Red					
Satd. Flow (RTOR)					
Link Speed (mph)					
Link Distance (ft)					
Travel Time (s)					
Peak Hour Factor					
Adj. Flow (vph)					
Shared Lane Traffic (%)					
Lane Group Flow (vph)					
Enter Blocked Intersection					
Lane Alignment					
Median Width(ft)					
Link Offset(ft)					
Crosswalk Width(ft)					
Two way Left Turn Lane					
Headway Factor					
Turning Speed (mph)					
Number of Detectors					
Detector Template					
Leading Detector (ft)					
Trailing Detector (ft)					
Detector 1 Position(ft)					
Detector 1 Size(ft)					
Detector 1 Type					
Detector 1 Channel					
Detector 1 Extend (s)					
Detector 1 Queue (s)					
Detector 1 Delay (s)					
Turn Type					
Protected Phases	1	4	5	6	7
Permitted Phases					
Detector Phase					
Switch Phase					
Minimum Initial (s)	6.0	4.0	10.0	12.0	6.0
Minimum Split (s)	11.5	16.0	15.6	17.5	12.8
Total Split (s)	18.0	16.0	18.0	31.0	41.0

Attachment E-4 – Synchro Analysis
2020 PM

Lanes, Volumes, Timings
65: I-49 NB Ramp & 163rd St

07/10/2020

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Total Split (%)					34.4%	34.4%	27.8%		27.8%			
Maximum Green (s)					25.4	25.4	18.2		18.2			
Yellow Time (s)					3.6	3.6	3.6		3.6			
All-Red Time (s)					2.0	2.0	3.2		3.2			
Lost Time Adjust (s)					0.0	0.0	0.0		0.0			
Total Lost Time (s)					5.6	5.6	6.8		6.8			
Lead/Lag					Lead	Lead	Lead		Lead			
Lead-Lag Optimize?					Yes	Yes	Yes		Yes			
Vehicle Extension (s)					4.0	4.0	4.0		4.0			
Recall Mode					C-Min	C-Min	None		None			
Act Effect Green (s)	28.7	63.0			23.2	23.2	14.7		14.7			
Actuated g/C Ratio	0.32	0.70			0.26	0.26	0.16		0.16			
v/c Ratio	0.58	0.33			0.39	0.46	0.62		0.25			
Control Delay	10.1	5.8			28.2	5.9	44.1		1.3			
Queue Delay	0.0	0.4			0.0	0.0	0.0		0.0			
Total Delay	10.1	6.2			28.2	5.9	44.1		1.3			
LOS	B	A			C	A	D		A			
Approach Delay		7.9			20.2			27.0				
Approach LOS		A			C			C				

Intersection Summary

Area Type: Other

Cycle Length: 90

Actuated Cycle Length: 90

Offset: 0 (0%), Referenced to phase 2:EBWB and 6:, Start of 1st Green

Natural Cycle: 75

Control Type: Actuated-Coordinated

Maximum v/c Ratio: 0.97

Intersection Signal Delay: 13.9

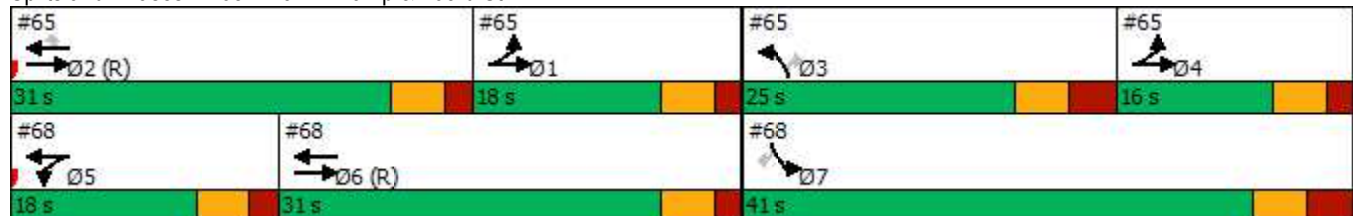
Intersection LOS: B

Intersection Capacity Utilization 90.5%

ICU Level of Service E

Analysis Period (min) 15

Splits and Phases: 65: I-49 NB Ramp & 163rd St



**Lanes, Volumes, Timings
65: I-49 NB Ramp & 163rd St**

07/10/2020

Lane Group	Ø1	Ø4	Ø5	Ø6	Ø7
Total Split (%)	20%	18%	20%	34%	46%
Maximum Green (s)	12.5	10.5	12.4	25.5	34.2
Yellow Time (s)	3.6	3.6	3.6	3.6	3.6
All-Red Time (s)	1.9	1.9	2.0	1.9	3.2
Lost Time Adjust (s)					
Total Lost Time (s)					
Lead/Lag	Lag	Lag	Lead	Lag	
Lead-Lag Optimize?	Yes	Yes	Yes	Yes	
Vehicle Extension (s)	4.0	3.0	4.0	4.0	4.0
Recall Mode	None	Min	None	C-Min	None
Act Effect Green (s)					
Actuated g/C Ratio					
v/c Ratio					
Control Delay					
Queue Delay					
Total Delay					
LOS					
Approach Delay					
Approach LOS					
Intersection Summary					

**Attachment E-4 – Synchro Analysis
2020 PM**

Lanes, Volumes, Timings
68: I-49 SB Ramp & 163rd St

07/10/2020

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	877	211	128	479	0	0	0	0	467	0	663
Future Volume (vph)	0	877	211	128	479	0	0	0	0	467	0	663
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	390		0	0		0	0			0	285	340
Storage Lanes	2		0	1		0	0			0	1	1
Taper Length (ft)	110			0			0			120		
Lane Util. Factor	1.00	0.86	0.86	1.00	0.95	1.00	1.00	1.00	1.00	0.97	1.00	1.00
Frt		0.966										0.850
Flt Protected				0.950						0.950		
Satd. Flow (prot)	0	6190	0	1770	3539	0	0	0	0	3433	0	1583
Flt Permitted				0.950						0.950		
Satd. Flow (perm)	0	6190	0	1770	3539	0	0	0	0	3433	0	1583
Right Turn on Red			Yes			Yes				Yes		Yes
Satd. Flow (RTOR)		83										259
Link Speed (mph)		35			35			40			40	
Link Distance (ft)		630			335			800			782	
Travel Time (s)		12.3			6.5			13.6			13.3	
Peak Hour Factor	0.92	0.94	0.76	0.75	0.90	0.92	0.92	0.92	0.92	0.91	0.92	0.91
Adj. Flow (vph)	0	933	278	171	532	0	0	0	0	513	0	729
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	1211	0	171	532	0	0	0	0	513	0	729
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Right	Left	Right
Median Width(ft)		20			20			24			24	
Link Offset(ft)		0			0			0			0	
Crosswalk Width(ft)		16			16			16			16	
Two way Left Turn Lane												
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Turning Speed (mph)	15		9	15		9	15			9	15	9
Number of Detectors		1		1	1					1		1
Detector Template		Thru		Left	Thru					Left		Right
Leading Detector (ft)		30		30	30					30		30
Trailing Detector (ft)		0		0	0					0		0
Detector 1 Position(ft)		0		0	0					0		0
Detector 1 Size(ft)		30		30	30					30		30
Detector 1 Type		Cl+Ex		Cl+Ex	Cl+Ex					Cl+Ex		Cl+Ex
Detector 1 Channel												
Detector 1 Extend (s)		0.0		0.0	0.0					0.0		0.0
Detector 1 Queue (s)		0.0		0.0	0.0					0.0		0.0
Detector 1 Delay (s)		0.0		0.0	0.0					0.0		0.0
Turn Type		NA		Prot	NA					Prot		Perm
Protected Phases		6		5	5 6					7		
Permitted Phases												7
Detector Phase		6		5	5 6					7		7
Switch Phase												
Minimum Initial (s)		12.0		10.0						6.0		6.0
Minimum Split (s)		17.5		15.6						12.8		12.8
Total Split (s)		31.0		18.0						41.0		41.0

Lanes, Volumes, Timings
68: I-49 SB Ramp & 163rd St

07/10/2020

Lane Group	Ø1	Ø2	Ø3	Ø4
Lane Configurations				
Traffic Volume (vph)				
Future Volume (vph)				
Ideal Flow (vphpl)				
Storage Length (ft)				
Storage Lanes				
Taper Length (ft)				
Lane Util. Factor				
Frt				
Flt Protected				
Satd. Flow (prot)				
Flt Permitted				
Satd. Flow (perm)				
Right Turn on Red				
Satd. Flow (RTOR)				
Link Speed (mph)				
Link Distance (ft)				
Travel Time (s)				
Peak Hour Factor				
Adj. Flow (vph)				
Shared Lane Traffic (%)				
Lane Group Flow (vph)				
Enter Blocked Intersection				
Lane Alignment				
Median Width(ft)				
Link Offset(ft)				
Crosswalk Width(ft)				
Two way Left Turn Lane				
Headway Factor				
Turning Speed (mph)				
Number of Detectors				
Detector Template				
Leading Detector (ft)				
Trailing Detector (ft)				
Detector 1 Position(ft)				
Detector 1 Size(ft)				
Detector 1 Type				
Detector 1 Channel				
Detector 1 Extend (s)				
Detector 1 Queue (s)				
Detector 1 Delay (s)				
Turn Type				
Protected Phases	1	2	3	4
Permitted Phases				
Detector Phase				
Switch Phase				
Minimum Initial (s)	6.0	12.0	6.0	4.0
Minimum Split (s)	11.5	17.6	12.8	16.0
Total Split (s)	18.0	31.0	25.0	16.0

**Attachment E-4 – Synchro Analysis
2020 PM**

Lanes, Volumes, Timings
68: I-49 SB Ramp & 163rd St

07/10/2020

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Total Split (%)		34.4%		20.0%						45.6%		45.6%
Maximum Green (s)		25.5		12.4						34.2		34.2
Yellow Time (s)		3.6		3.6						3.6		3.6
All-Red Time (s)		1.9		2.0						3.2		3.2
Lost Time Adjust (s)		0.0		0.0						0.0		0.0
Total Lost Time (s)		5.5		5.6						6.8		6.8
Lead/Lag		Lag		Lead								
Lead-Lag Optimize?		Yes		Yes								
Vehicle Extension (s)		4.0		4.0						4.0		4.0
Recall Mode		C-Min		None						None		None
Act Effect Green (s)		26.2		12.2	43.9					33.7		33.7
Actuated g/C Ratio		0.29		0.14	0.49					0.37		0.37
v/c Ratio		0.65		0.72	0.31					0.40		0.97
Control Delay		28.0		47.2	8.8					21.7		44.7
Queue Delay		0.0		0.0	0.0					0.0		0.0
Total Delay		28.0		47.2	8.8					21.7		44.7
LOS		C		D	A					C		D
Approach Delay		28.0			18.1						35.2	
Approach LOS		C			B						D	

Intersection Summary

Area Type: Other

Cycle Length: 90

Actuated Cycle Length: 90

Offset: 0 (0%), Referenced to phase 2:EBWB and 6:, Start of 1st Green

Natural Cycle: 75

Control Type: Actuated-Coordinated

Maximum v/c Ratio: 0.97

Intersection Signal Delay: 28.6

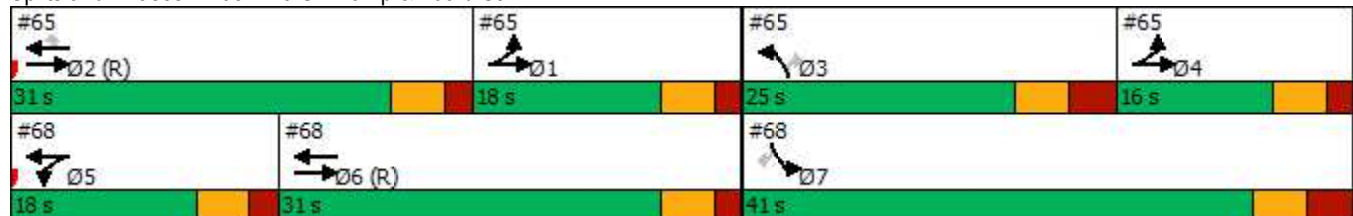
Intersection LOS: C

Intersection Capacity Utilization 90.5%

ICU Level of Service E

Analysis Period (min) 15

Splits and Phases: 68: I-49 SB Ramp & 163rd St



**Lanes, Volumes, Timings
68: I-49 SB Ramp & 163rd St**

07/10/2020

Lane Group	Ø1	Ø2	Ø3	Ø4
Total Split (%)	20%	34%	28%	18%
Maximum Green (s)	12.5	25.4	18.2	10.5
Yellow Time (s)	3.6	3.6	3.6	3.6
All-Red Time (s)	1.9	2.0	3.2	1.9
Lost Time Adjust (s)				
Total Lost Time (s)				
Lead/Lag	Lag	Lead	Lead	Lag
Lead-Lag Optimize?	Yes	Yes	Yes	Yes
Vehicle Extension (s)	4.0	4.0	4.0	3.0
Recall Mode	None	C-Min	None	Min
Act Effect Green (s)				
Actuated g/C Ratio				
v/c Ratio				
Control Delay				
Queue Delay				
Total Delay				
LOS				
Approach Delay				
Approach LOS				
Intersection Summary				

**Attachment E-4 – Synchro Analysis
2023 AM**

**Lanes, Volumes, Timings
1: Harmon Drive & Route 58**

07/10/2020

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	133	774	109	18	1301	43	411	21	19	38	12	56
Future Volume (vph)	133	774	109	18	1301	43	411	21	19	38	12	56
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		0%			-1%			1%			3%	
Storage Length (ft)	90		0	205		135	200		40	130		55
Storage Lanes	1		0	1		0	1		0	1		0
Taper Length (ft)	25			25			25			25		
Lane Util. Factor	1.00	0.95	0.95	1.00	0.91	0.91	1.00	1.00	1.00	1.00	1.00	1.00
Frt		0.982			0.995			0.929			0.876	
Flt Protected	0.950			0.950			0.950			0.950		
Satd. Flow (prot)	1770	3434	0	1620	5088	0	1761	1691	0	1726	1613	0
Flt Permitted	0.196			0.202			0.374			0.816		
Satd. Flow (perm)	365	3434	0	344	5088	0	693	1691	0	1483	1613	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		23			7			19			57	
Link Speed (mph)		40			40			45			45	
Link Distance (ft)		302			504			437			563	
Travel Time (s)		5.1			8.6			6.6			8.5	
Peak Hour Factor	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Heavy Vehicles (%)	2%	3%	5%	12%	2%	0%	2%	1%	7%	3%	0%	2%
Adj. Flow (vph)	136	790	111	18	1328	44	419	21	19	39	12	57
Shared Lane Traffic (%)												
Lane Group Flow (vph)	136	901	0	18	1372	0	419	40	0	39	69	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(ft)		12			12			12			12	
Link Offset(ft)		0			0			0			0	
Crosswalk Width(ft)		16			16			16			16	
Two way Left Turn Lane												
Headway Factor	1.00	1.00	1.00	0.99	0.99	0.99	1.01	1.01	1.01	1.02	1.02	1.02
Turning Speed (mph)	15		9	15		9	15		9	15		9
Number of Detectors	1	1		1	1		1	1		1	1	
Detector Template	Left	Thru		Left	Thru		Left	Thru		Left	Thru	
Leading Detector (ft)	30	30		30	30		30	30		30	30	
Trailing Detector (ft)	0	0		0	0		0	0		0	0	
Detector 1 Position(ft)	0	0		0	0		0	0		0	0	
Detector 1 Size(ft)	30	30		30	30		30	30		30	30	
Detector 1 Type	Cl+Ex	Cl+Ex		Cl+Ex	Cl+Ex		Cl+Ex	Cl+Ex		Cl+Ex	Cl+Ex	
Detector 1 Channel												
Detector 1 Extend (s)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Detector 1 Queue (s)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Detector 1 Delay (s)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Turn Type	D.P+P	NA		D.P+P	NA		pm+pt	NA		pm+pt	NA	
Protected Phases	1	6		5	2		7	4		3	8	
Permitted Phases	2			6			4			8		
Detector Phase	1	6		5	2		7	4		3	8	
Switch Phase												
Minimum Initial (s)	5.0	10.0		5.0	10.0		5.0	5.0		4.0	5.0	

**Attachment E-4 – Synchro Analysis
2023 AM**

**Lanes, Volumes, Timings
1: Harmon Drive & Route 58**

07/10/2020

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Minimum Split (s)	11.0	15.6		11.0	15.6		11.2	12.0		11.0	12.0	
Total Split (s)	11.0	27.0		11.0	27.0		20.0	21.0		11.0	12.0	
Total Split (%)	15.7%	38.6%		15.7%	38.6%		28.6%	30.0%		15.7%	17.1%	
Maximum Green (s)	5.4	21.4		5.4	21.4		14.2	15.2		5.2	6.2	
Yellow Time (s)	3.6	3.6		3.6	3.6		4.2	4.2		4.2	4.2	
All-Red Time (s)	2.0	2.0		2.0	2.0		1.6	1.6		1.6	1.6	
Lost Time Adjust (s)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Total Lost Time (s)	5.6	5.6		5.6	5.6		5.8	5.8		5.8	5.8	
Lead/Lag	Lag	Lag		Lead	Lead		Lead	Lag		Lead	Lag	
Lead-Lag Optimize?	Yes	Yes		Yes	Yes		Yes	Yes		Yes	Yes	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	4.0		3.0	4.0	
Recall Mode	None	C-Max		None	C-Max		None	None		None	None	
Walk Time (s)		7.0			7.0							
Flash Dont Walk (s)		16.0			21.0							
Pedestrian Calls (#/hr)		0			0							
Act Effect Green (s)	32.7	35.0		36.1	28.4		21.4	17.0		8.9	6.2	
Actuated g/C Ratio	0.47	0.50		0.52	0.41		0.31	0.24		0.13	0.09	
v/c Ratio	0.49	0.52		0.07	0.66		0.98	0.09		0.19	0.36	
Control Delay	13.6	8.0		10.8	21.5		62.3	14.5		19.0	17.4	
Queue Delay	0.0	0.1		0.0	0.0		0.0	0.0		0.0	0.0	
Total Delay	13.6	8.2		10.8	21.5		62.3	14.5		19.0	17.4	
LOS	B	A		B	C		E	B		B	B	
Approach Delay		8.9			21.4			58.1			18.0	
Approach LOS		A			C			E			B	

Intersection Summary

Area Type: Other

Cycle Length: 70

Actuated Cycle Length: 70

Offset: 67 (96%), Referenced to phase 2:EBWB and 6:EBWB, Start of 1st Green

Natural Cycle: 75

Control Type: Actuated-Coordinated

Maximum v/c Ratio: 0.98

Intersection Signal Delay: 22.6

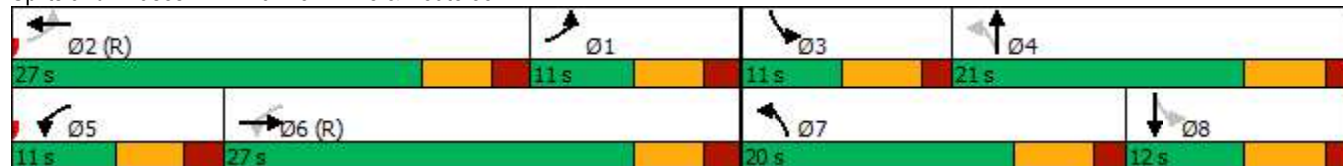
Intersection LOS: C

Intersection Capacity Utilization 77.1%

ICU Level of Service D

Analysis Period (min) 15

Splits and Phases: 1: Harmon Drive & Route 58



**Attachment E-4 – Synchro Analysis
2023 AM**

**Lanes, Volumes, Timings
2: I-49 NB Ramp & Route 58**

07/10/2020

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	268	817	0	0	590	1178	191	0	199	0	0	0
Future Volume (vph)	268	817	0	0	590	1178	191	0	199	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		0%			0%			1%			0%	
Storage Length (ft)	230		0	0		0	331		150	0		0
Storage Lanes	1		0	0		1	0		1	0		0
Taper Length (ft)	150			0			25			0		
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt						0.850			0.850			
Flt Protected	0.950						0.950					
Satd. Flow (prot)	1752	3505	0	0	3539	1599	1761	0	1545	0	0	0
Flt Permitted	0.359						0.950					
Satd. Flow (perm)	662	3505	0	0	3539	1599	1761	0	1545	0	0	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)						744			170			
Link Speed (mph)		40			40			40			40	
Link Distance (ft)		594			302			1070			450	
Travel Time (s)		10.1			5.1			18.2			7.7	
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Heavy Vehicles (%)	3%	3%	0%	0%	2%	1%	2%	0%	4%	0%	0%	0%
Adj. Flow (vph)	276	842	0	0	608	1214	197	0	205	0	0	0
Shared Lane Traffic (%)												
Lane Group Flow (vph)	276	842	0	0	608	1214	197	0	205	0	0	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(ft)		12			12			12			12	
Link Offset(ft)		0			0			0			0	
Crosswalk Width(ft)		16			16			16			16	
Two way Left Turn Lane												
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.01	1.01	1.01	1.00	1.00	1.00
Turning Speed (mph)	15		9	15		9	15		9	15		9
Number of Detectors	1	1			1	1	1		1			
Detector Template	Left	Thru			Thru	Right	Left		Right			
Leading Detector (ft)	30	30			30	30	30		30			
Trailing Detector (ft)	0	0			0	0	0		0			
Detector 1 Position(ft)	0	0			0	0	0		0			
Detector 1 Size(ft)	30	30			30	30	30		30			
Detector 1 Type	Cl+Ex	Cl+Ex			Cl+Ex	Cl+Ex	Cl+Ex		Cl+Ex			
Detector 1 Channel												
Detector 1 Extend (s)	0.0	0.0			0.0	0.0	0.0		0.0			
Detector 1 Queue (s)	0.0	0.0			0.0	0.0	0.0		0.0			
Detector 1 Delay (s)	0.0	0.0			0.0	0.0	0.0		0.0			
Turn Type	D.P+P	NA			NA	Free	Perm		Perm			
Protected Phases	1	6			2							
Permitted Phases	2					Free	7		7			
Detector Phase	1	6			2		7		7			
Switch Phase												
Minimum Initial (s)	5.0	10.0			10.0		8.0		8.0			

**Attachment E-4 – Synchro Analysis
2023 AM**

**Lanes, Volumes, Timings
2: I-49 NB Ramp & Route 58**

07/10/2020

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Minimum Split (s)	12.0	15.3			21.3		15.0		15.0			
Total Split (s)	19.0	47.0			28.0		23.0		23.0			
Total Split (%)	27.1%	67.1%			40.0%		32.9%		32.9%			
Maximum Green (s)	13.7	41.7			22.7		17.1		17.1			
Yellow Time (s)	3.6	3.6			3.6		3.9		3.9			
All-Red Time (s)	1.7	1.7			1.7		2.0		2.0			
Lost Time Adjust (s)	0.0	0.0			0.0		0.0		0.0			
Total Lost Time (s)	5.3	5.3			5.3		5.9		5.9			
Lead/Lag	Lag				Lead							
Lead-Lag Optimize?	Yes				Yes							
Vehicle Extension (s)	3.0	3.0			3.0		3.0		3.0			
Recall Mode	None	C-Max			C-Max		None		None			
Walk Time (s)		7.0			5.0							
Flash Dont Walk (s)		12.0			11.0							
Pedestrian Calls (#/hr)		0			0							
Act Effct Green (s)	40.7	46.0			27.0	70.0	12.8		12.8			
Actuated g/C Ratio	0.58	0.66			0.39	1.00	0.18		0.18			
v/c Ratio	0.46	0.37			0.45	0.76	0.61		0.49			
Control Delay	12.4	5.3			7.1	10.2	34.0		10.5			
Queue Delay	0.0	0.0			0.3	0.0	0.0		0.0			
Total Delay	12.4	5.3			7.3	10.2	34.0		10.5			
LOS	B	A			A	B	C		B			
Approach Delay		7.1			9.3			22.0				
Approach LOS		A			A			C				

Intersection Summary

Area Type: Other

Cycle Length: 70

Actuated Cycle Length: 70

Offset: 1 (1%), Referenced to phase 2:EBWB and 6:EBT, Start of 1st Green

Natural Cycle: 50

Control Type: Actuated-Coordinated

Maximum v/c Ratio: 0.76

Intersection Signal Delay: 10.1

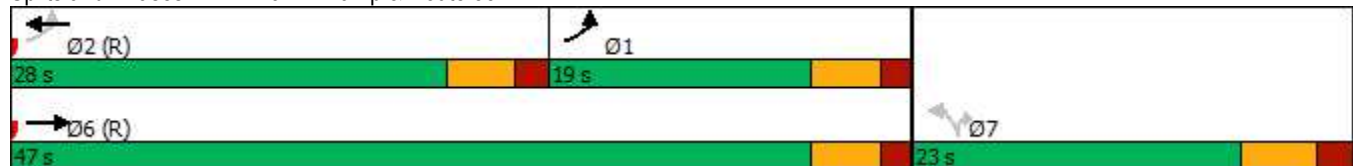
Intersection LOS: B

Intersection Capacity Utilization 55.5%

ICU Level of Service B

Analysis Period (min) 15

Splits and Phases: 2: I-49 NB Ramp & Route 58



**Attachment E-4 – Synchro Analysis
2023 AM**

**Lanes, Volumes, Timings
3: I-49 SB Ramp & Route 58**

07/10/2020

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	666	113	76	705	0	0	0	0	419	0	164
Future Volume (vph)	0	666	113	76	705	0	0	0	0	419	0	164
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		1%			0%			0%			2%	
Storage Length (ft)	0		0	140		0	0		0	0		350
Storage Lanes	0		0	1		0	0		0	2		1
Taper Length (ft)	0			150			0			0		
Lane Util. Factor	1.00	0.95	0.95	1.00	0.95	1.00	1.00	1.00	1.00	0.97	1.00	1.00
Frt		0.978										0.850
Flt Protected				0.950						0.950		
Satd. Flow (prot)	0	3401	0	1752	3539	0	0	0	0	3366	0	1552
Flt Permitted				0.280						0.950		
Satd. Flow (perm)	0	3401	0	517	3539	0	0	0	0	3366	0	1552
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		35										171
Link Speed (mph)		40			40			40			40	
Link Distance (ft)		315			594			338			1069	
Travel Time (s)		5.4			10.1			5.8			18.2	
Peak Hour Factor	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Heavy Vehicles (%)	0%	3%	5%	3%	2%	0%	0%	0%	0%	3%	0%	3%
Adj. Flow (vph)	0	694	118	79	734	0	0	0	0	436	0	171
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	812	0	79	734	0	0	0	0	436	0	171
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(ft)		12			12			24			24	
Link Offset(ft)		0			0			0			0	
Crosswalk Width(ft)		16			16			16			16	
Two way Left Turn Lane												
Headway Factor	1.01	1.01	1.01	1.00	1.00	1.00	1.00	1.00	1.00	1.01	1.01	1.01
Turning Speed (mph)	15		9	15		9	15		9	15		9
Number of Detectors		1		1	1					1		1
Detector Template		Thru		Left	Thru					Left		Right
Leading Detector (ft)		30		30	30					30		30
Trailing Detector (ft)		0		0	0					0		0
Detector 1 Position(ft)		0		0	0					0		0
Detector 1 Size(ft)		30		30	30					30		30
Detector 1 Type		Cl+Ex		Cl+Ex	Cl+Ex					Cl+Ex		Cl+Ex
Detector 1 Channel												
Detector 1 Extend (s)		0.0		0.0	0.0					0.0		0.0
Detector 1 Queue (s)		0.0		0.0	0.0					0.0		0.0
Detector 1 Delay (s)		0.0		0.0	0.0					0.0		0.0
Turn Type		NA		D,P+P	NA					Prot		Prot
Protected Phases		6		5	2					3		3
Permitted Phases				6								
Detector Phase		6		5	2					3		3
Switch Phase												
Minimum Initial (s)		10.0		6.0	10.0					8.0		8.0

**Attachment E-4 – Synchro Analysis
2023 AM**

**Lanes, Volumes, Timings
3: I-49 SB Ramp & Route 58**

07/10/2020

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Minimum Split (s)		21.6		12.0	21.6					15.0		15.0
Total Split (s)		36.0		12.0	48.0					22.0		22.0
Total Split (%)		51.4%		17.1%	68.6%					31.4%		31.4%
Maximum Green (s)		30.4		6.4	42.4					16.1		16.1
Yellow Time (s)		3.6		3.6	3.6					3.9		3.9
All-Red Time (s)		2.0		2.0	2.0					2.0		2.0
Lost Time Adjust (s)		0.0		0.0	0.0					0.0		0.0
Total Lost Time (s)		5.6		5.6	5.6					5.9		5.9
Lead/Lag		Lead		Lag								
Lead-Lag Optimize?		Yes		Yes								
Vehicle Extension (s)		5.0		5.0	3.0					6.0		6.0
Recall Mode		C-Max		None	C-Max					None		None
Walk Time (s)		7.0			7.0							
Flash Dont Walk (s)		21.0			10.0							
Pedestrian Calls (#/hr)		0			0							
Act Effect Green (s)		33.4		38.5	43.0					15.5		15.5
Actuated g/C Ratio		0.48		0.55	0.61					0.22		0.22
v/c Ratio		0.50		0.20	0.34					0.59		0.36
Control Delay		8.3		2.7	1.6					27.8		6.5
Queue Delay		0.1		0.0	0.0					0.0		0.0
Total Delay		8.4		2.7	1.6					27.8		6.5
LOS		A		A	A					C		A
Approach Delay		8.4			1.7						21.8	
Approach LOS		A			A						C	

Intersection Summary

Area Type: Other

Cycle Length: 70

Actuated Cycle Length: 70

Offset: 66 (94%), Referenced to phase 2:WBT and 6:EBWB, Start of 1st Green

Natural Cycle: 50

Control Type: Actuated-Coordinated

Maximum v/c Ratio: 0.59

Intersection Signal Delay: 9.6

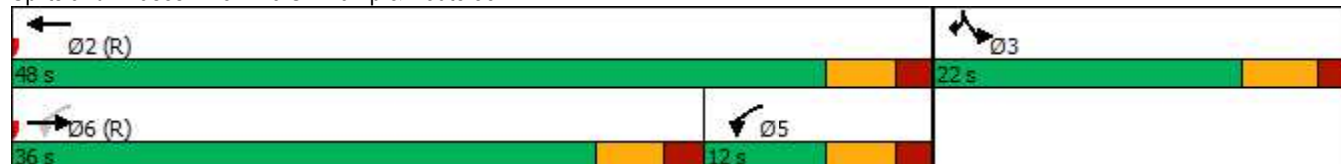
Intersection LOS: A

Intersection Capacity Utilization 55.5%

ICU Level of Service B

Analysis Period (min) 15

Splits and Phases: 3: I-49 SB Ramp & Route 58



**Attachment E-4 – Synchro Analysis
2023 AM**

**Lanes, Volumes, Timings
4: Peculiar Dr & Route 58**

07/10/2020

						
Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↑↑		↵	↑↑	↵	
Traffic Volume (vph)	560	1	49	820	50	219
Future Volume (vph)	560	1	49	820	50	219
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Grade (%)	2%			-1%	2%	
Storage Length (ft)		0	140		307	60
Storage Lanes		0	1		0	0
Taper Length (ft)			25		25	
Lane Util. Factor	0.95	0.95	1.00	0.95	1.00	1.00
Frt					0.890	
Flt Protected			0.950		0.991	
Satd. Flow (prot)	3470	0	1744	3557	1549	0
Flt Permitted			0.394		0.991	
Satd. Flow (perm)	3470	0	723	3557	1549	0
Right Turn on Red		Yes				Yes
Satd. Flow (RTOR)					246	
Link Speed (mph)	40			40	45	
Link Distance (ft)	881			315	346	
Travel Time (s)	15.0			5.4	5.2	
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89
Heavy Vehicles (%)	3%	0%	4%	2%	3%	8%
Adj. Flow (vph)	629	1	55	921	56	246
Shared Lane Traffic (%)						
Lane Group Flow (vph)	630	0	55	921	302	0
Enter Blocked Intersection	No	No	No	No	No	No
Lane Alignment	Left	Right	Left	Left	Left	Right
Median Width(ft)	12			12	12	
Link Offset(ft)	0			0	0	
Crosswalk Width(ft)	16			16	16	
Two way Left Turn Lane						
Headway Factor	1.01	1.01	0.99	0.99	1.01	1.01
Turning Speed (mph)		9	15		15	9
Number of Detectors	1		1	1	1	
Detector Template	Thru		Left	Thru	Left	
Leading Detector (ft)	30		30	30	30	
Trailing Detector (ft)	0		0	0	0	
Detector 1 Position(ft)	0		0	0	0	
Detector 1 Size(ft)	30		30	30	30	
Detector 1 Type	Cl+Ex		Cl+Ex	Cl+Ex	Cl+Ex	
Detector 1 Channel						
Detector 1 Extend (s)	0.0		0.0	0.0	0.0	
Detector 1 Queue (s)	0.0		0.0	0.0	0.0	
Detector 1 Delay (s)	0.0		0.0	0.0	0.0	
Turn Type	NA		D.P+P	NA	Prot	
Protected Phases	6		5	2	7	
Permitted Phases			6			
Detector Phase	6		5	2	7	
Switch Phase						
Minimum Initial (s)	10.0		6.0	10.0	8.0	

**Attachment E-4 – Synchro Analysis
2023 AM**

**Lanes, Volumes, Timings
4: Peculiar Dr & Route 58**

07/10/2020

	→	↘	↙	←	↖	↗
Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Minimum Split (s)	21.1		11.1	21.1	15.0	
Total Split (s)	32.0		12.0	44.0	26.0	
Total Split (%)	45.7%		17.1%	62.9%	37.1%	
Maximum Green (s)	26.9		6.9	38.9	20.5	
Yellow Time (s)	3.6		3.6	3.6	3.6	
All-Red Time (s)	1.5		1.5	1.5	1.9	
Lost Time Adjust (s)	0.0		0.0	0.0	0.0	
Total Lost Time (s)	5.1		5.1	5.1	5.5	
Lead/Lag	Lead		Lag			
Lead-Lag Optimize?	Yes		Yes			
Vehicle Extension (s)	3.0		3.0	3.0	3.0	
Recall Mode	C-Max		None	C-Max	None	
Walk Time (s)	7.0					
Flash Dont Walk (s)	11.0					
Pedestrian Calls (#/hr)	0					
Act Effect Green (s)	41.6		45.8	48.8	10.6	
Actuated g/C Ratio	0.59		0.65	0.70	0.15	
v/c Ratio	0.31		0.10	0.37	0.68	
Control Delay	9.4		2.0	1.6	15.0	
Queue Delay	0.0		0.0	0.1	0.0	
Total Delay	9.4		2.0	1.7	15.0	
LOS	A		A	A	B	
Approach Delay	9.4			1.7	15.0	
Approach LOS	A			A	B	

Intersection Summary

Area Type: Other

Cycle Length: 70

Actuated Cycle Length: 70

Offset: 0 (0%), Referenced to phase 2:WBT and 6:EBWB, Start of 1st Green

Natural Cycle: 50

Control Type: Actuated-Coordinated

Maximum v/c Ratio: 0.68

Intersection Signal Delay: 6.3

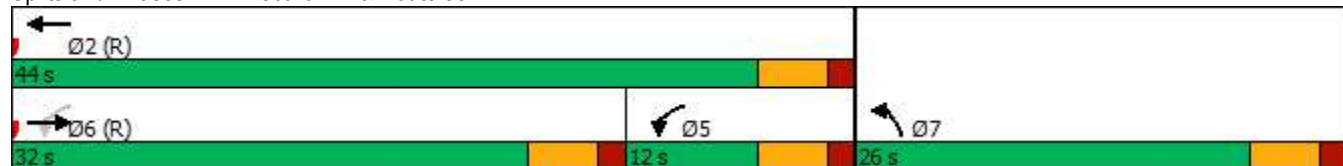
Intersection LOS: A

Intersection Capacity Utilization 49.9%

ICU Level of Service A

Analysis Period (min) 15

Splits and Phases: 4: Peculiar Dr & Route 58



**Attachment E-4 – Synchro Analysis
2023 AM**

Lanes, Volumes, Timings

30: I-49 SB Ramp & N. Cass Parkway

07/10/2020

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑↑↑	↑	↑	↑↑					↑↑		↑
Traffic Volume (vph)	0	109	32	158	149	0	0	0	0	53	0	17
Future Volume (vph)	0	109	32	158	149	0	0	0	0	53	0	17
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	60		290	0		0	0		0	380		380
Storage Lanes	1		1	1		0	0		0	1		1
Taper Length (ft)	25			0			0			25		
Lane Util. Factor	1.00	0.91	1.00	1.00	0.95	1.00	1.00	1.00	1.00	0.97	1.00	1.00
Frt			0.850									0.850
Flt Protected				0.950						0.950		
Satd. Flow (prot)	0	5085	1583	1770	3539	0	0	0	0	3433	0	1583
Flt Permitted				0.460						0.950		
Satd. Flow (perm)	0	5085	1583	857	3539	0	0	0	0	3433	0	1583
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)			179									192
Link Speed (mph)		45			45			40			40	
Link Distance (ft)		607			634			565			826	
Travel Time (s)		9.2			9.6			9.6			14.1	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	118	35	172	162	0	0	0	0	58	0	18
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	118	35	172	162	0	0	0	0	58	0	18
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(ft)		12			12			24			24	
Link Offset(ft)		0			0			0			0	
Crosswalk Width(ft)		16			16			16			16	
Two way Left Turn Lane												
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Turning Speed (mph)	15		9	15		9	15		9	15		9
Number of Detectors		2	1	1	2					1		1
Detector Template		Thru	Right	Left	Thru					Left		Right
Leading Detector (ft)		100	20	20	100					20		20
Trailing Detector (ft)		0	0	0	0					0		0
Detector 1 Position(ft)		0	0	0	0					0		0
Detector 1 Size(ft)		6	20	20	6					20		20
Detector 1 Type		Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex					Cl+Ex		Cl+Ex
Detector 1 Channel												
Detector 1 Extend (s)		0.0	0.0	0.0	0.0					0.0		0.0
Detector 1 Queue (s)		0.0	0.0	0.0	0.0					0.0		0.0
Detector 1 Delay (s)		0.0	0.0	0.0	0.0					0.0		0.0
Detector 2 Position(ft)		94			94							
Detector 2 Size(ft)		6			6							
Detector 2 Type		Cl+Ex			Cl+Ex							
Detector 2 Channel												
Detector 2 Extend (s)		0.0			0.0							
Turn Type		NA	Perm	pm+pt	NA					Prot		Perm
Protected Phases		4		3	8					5		
Permitted Phases			4	8								5

**Attachment E-4 – Synchro Analysis
2023 AM**

Lanes, Volumes, Timings

30: I-49 SB Ramp & N. Cass Parkway

07/10/2020

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Detector Phase		4	4	3	8					5		5
Switch Phase												
Minimum Initial (s)		10.0	10.0	7.0	10.0					7.0		7.0
Minimum Split (s)		21.6	21.6	12.5	21.2					12.7		12.7
Total Split (s)		22.0	22.0	13.0	35.0					15.0		15.0
Total Split (%)		44.0%	44.0%	26.0%	70.0%					30.0%		30.0%
Maximum Green (s)		15.7	15.7	7.5	29.8					9.3		9.3
Yellow Time (s)		4.8	4.8	4.1	4.1					4.0		4.0
All-Red Time (s)		1.5	1.5	1.4	1.1					1.7		1.7
Lost Time Adjust (s)		0.0	0.0	0.0	0.0					0.0		0.0
Total Lost Time (s)		6.3	6.3	5.5	5.2					5.7		5.7
Lead/Lag		Lag	Lag	Lead								
Lead-Lag Optimize?		Yes	Yes	Yes								
Vehicle Extension (s)		3.0	3.0	3.0	3.0					3.0		3.0
Recall Mode		Min	Min	None	Min					None		None
Act Effect Green (s)		11.9	11.9	18.4	15.4					25.7		25.7
Actuated g/C Ratio		0.24	0.24	0.37	0.31					0.51		0.51
v/c Ratio		0.10	0.07	0.37	0.15					0.03		0.02
Control Delay		15.3	0.2	5.9	1.5					13.0		0.1
Queue Delay		0.0	0.0	0.0	0.0					0.0		0.0
Total Delay		15.3	0.2	5.9	1.5					13.0		0.1
LOS		B	A	A	A					B		A
Approach Delay		11.8			3.8						9.9	
Approach LOS		B			A						A	

Intersection Summary

Area Type: Other

Cycle Length: 50

Actuated Cycle Length: 50

Offset: 26 (52%), Referenced to phase 2: and 6:, Start of Green

Natural Cycle: 50

Control Type: Actuated-Coordinated

Maximum v/c Ratio: 0.37

Intersection Signal Delay: 6.8

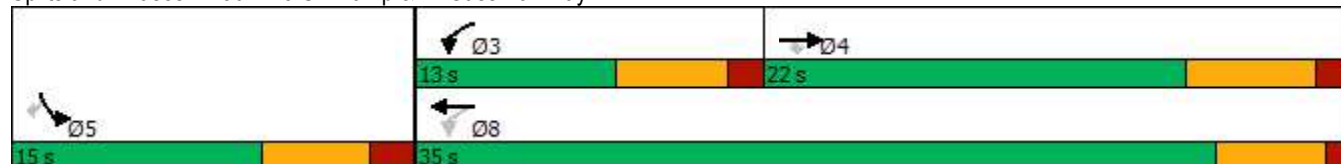
Intersection LOS: A

Intersection Capacity Utilization 37.5%

ICU Level of Service A

Analysis Period (min) 15

Splits and Phases: 30: I-49 SB Ramp & N. Cass Parkway



**Attachment E-4 – Synchro Analysis
2023 AM**

Lanes, Volumes, Timings

33: I-49 NB Ramp & N. Cass Parkway

07/10/2020

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		 			  							
Traffic Volume (vph)	80	82	0	0	223	294	84	0	124	0	0	0
Future Volume (vph)	80	82	0	0	223	294	84	0	124	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0		0	60		320	285		285	0		0
Storage Lanes	1		0	1		1	0		1	0		0
Taper Length (ft)	0			25			25			0		
Lane Util. Factor	1.00	0.95	1.00	1.00	0.91	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt						0.850			0.850			
Flt Protected	0.950						0.950					
Satd. Flow (prot)	1770	3539	0	0	5085	1583	1770	0	1583	0	0	0
Flt Permitted	0.316						0.950					
Satd. Flow (perm)	589	3539	0	0	5085	1583	1770	0	1583	0	0	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)						320			188			
Link Speed (mph)		45			45			40			40	
Link Distance (ft)		634			604			748			707	
Travel Time (s)		9.6			9.2			12.8			12.1	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	87	89	0	0	242	320	91	0	135	0	0	0
Shared Lane Traffic (%)												
Lane Group Flow (vph)	87	89	0	0	242	320	91	0	135	0	0	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(ft)		12			12			12			12	
Link Offset(ft)		0			0			0			0	
Crosswalk Width(ft)		16			0			16			16	
Two way Left Turn Lane												
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Turning Speed (mph)	15		9	15		9	15		9	15		9
Number of Detectors	1	2			2	1	1		1			
Detector Template	Left	Thru			Thru	Right	Left		Right			
Leading Detector (ft)	20	100			100	20	20		20			
Trailing Detector (ft)	0	0			0	0	0		0			
Detector 1 Position(ft)	0	0			0	0	0		0			
Detector 1 Size(ft)	20	6			6	20	20		20			
Detector 1 Type	Cl+Ex	Cl+Ex			Cl+Ex	Cl+Ex	Cl+Ex		Cl+Ex			
Detector 1 Channel												
Detector 1 Extend (s)	0.0	0.0			0.0	0.0	0.0		0.0			
Detector 1 Queue (s)	0.0	0.0			0.0	0.0	0.0		0.0			
Detector 1 Delay (s)	0.0	0.0			0.0	0.0	0.0		0.0			
Detector 2 Position(ft)		94			94							
Detector 2 Size(ft)		6			6							
Detector 2 Type		Cl+Ex			Cl+Ex							
Detector 2 Channel												
Detector 2 Extend (s)		0.0			0.0							
Turn Type	pm+pt	NA			NA	Free	Prot		Perm			
Protected Phases	3	8			4		5					
Permitted Phases	8					Free			5			

Scenario 1 5:00 pm 10/08/2019 Baseline

Synchro 11 Report
Page 11

**Attachment E-4 – Synchro Analysis
2023 AM**

Lanes, Volumes, Timings

33: I-49 NB Ramp & N. Cass Parkway

07/10/2020

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Detector Phase	3	8			4		5		5			
Switch Phase												
Minimum Initial (s)	7.0	10.0			10.0		7.0		7.0			
Minimum Split (s)	13.1	20.0			20.0		12.4		12.4			
Total Split (s)	14.0	34.0			20.0		16.0		16.0			
Total Split (%)	28.0%	68.0%			40.0%		32.0%		32.0%			
Maximum Green (s)	7.9	28.5			14.6		10.6		10.6			
Yellow Time (s)	4.5	4.5			4.0		4.0		4.0			
All-Red Time (s)	1.6	1.0			1.4		1.4		1.4			
Lost Time Adjust (s)	0.0	0.0			0.0		0.0		0.0			
Total Lost Time (s)	6.1	5.5			5.4		5.4		5.4			
Lead/Lag	Lead				Lag							
Lead-Lag Optimize?	Yes				Yes							
Vehicle Extension (s)	3.0	3.0			3.0		3.0		3.0			
Recall Mode	None	Min			Min		None		None			
Act Effct Green (s)	17.1	16.2			8.0	50.0	24.0		24.0			
Actuated g/C Ratio	0.34	0.32			0.16	1.00	0.48		0.48			
v/c Ratio	0.23	0.08			0.30	0.20	0.11		0.16			
Control Delay	4.7	2.7			18.0	0.3	12.6		1.8			
Queue Delay	0.0	0.0			0.0	0.0	0.0		0.0			
Total Delay	4.7	2.7			18.0	0.3	12.6		1.8			
LOS	A	A			B	A	B		A			
Approach Delay		3.7			7.9			6.1				
Approach LOS		A			A			A				

Intersection Summary

Area Type: Other

Cycle Length: 50

Actuated Cycle Length: 50

Offset: 0 (0%), Referenced to phase 2: and 6:, Start of Green

Natural Cycle: 50

Control Type: Actuated-Coordinated

Maximum v/c Ratio: 0.30

Intersection Signal Delay: 6.7

Intersection LOS: A

Intersection Capacity Utilization 37.5%

ICU Level of Service A

Analysis Period (min) 15

Splits and Phases: 33: I-49 NB Ramp & N. Cass Parkway



**Attachment E-4 – Synchro Analysis
2023 AM**

Lanes, Volumes, Timings

65: I-49 NB Ramp & 163rd St./163rd St

07/10/2020

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	667	322	0	0	690	618	215	0	161	0	0	0
Future Volume (vph)	667	322	0	0	690	618	215	0	161	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0		0	255		520	0		135	0		0
Storage Lanes	2		0	1		1	1		1	0		0
Taper Length (ft)	0			100			0			0		
Lane Util. Factor	0.97	0.95	1.00	1.00	0.91	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt						0.850			0.850			
Flt Protected	0.950						0.950					
Satd. Flow (prot)	3433	3539	0	0	5085	1583	1770	0	1583	0	0	0
Flt Permitted	0.950						0.950					
Satd. Flow (perm)	3433	3539	0	0	5085	1583	1770	0	1583	0	0	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)						445			223			
Link Speed (mph)		35			35			40			40	
Link Distance (ft)		335			638			919			594	
Travel Time (s)		6.5			12.4			15.7			10.1	
Peak Hour Factor	0.76	0.84	0.92	0.92	0.71	0.91	0.75	0.92	0.75	0.92	0.92	0.92
Adj. Flow (vph)	878	383	0	0	972	679	287	0	215	0	0	0
Shared Lane Traffic (%)												
Lane Group Flow (vph)	878	383	0	0	972	679	287	0	215	0	0	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Right	Right	Right	Left	Left	Right	Left	Left	Right
Median Width(ft)		24			24			12			12	
Link Offset(ft)		0			0			0			0	
Crosswalk Width(ft)		16			16			16			16	
Two way Left Turn Lane												
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Turning Speed (mph)	15		9	15		9	15		9	15		9
Number of Detectors	1	1			1	1	1		1			
Detector Template	Left	Thru			Thru	Right	Left		Right			
Leading Detector (ft)	30	30			30	30	30		30			
Trailing Detector (ft)	0	0			0	0	0		0			
Detector 1 Position(ft)	0	0			0	0	0		0			
Detector 1 Size(ft)	30	30			30	30	30		30			
Detector 1 Type	Cl+Ex	Cl+Ex			Cl+Ex	Cl+Ex	Cl+Ex		Cl+Ex			
Detector 1 Channel												
Detector 1 Extend (s)	0.0	0.0			0.0	0.0	0.0		0.0			
Detector 1 Queue (s)	0.0	0.0			0.0	0.0	0.0		0.0			
Detector 1 Delay (s)	0.0	0.0			0.0	0.0	0.0		0.0			
Turn Type	Prot	NA			NA	Perm	Prot		Perm			
Protected Phases	1	1 2			2		3					
Permitted Phases						2			3			
Detector Phase	1	1 2			2	2	3		3			
Switch Phase												
Minimum Initial (s)	6.0				12.0	12.0	6.0		6.0			
Minimum Split (s)	11.8				17.8	17.8	12.8		12.8			
Total Split (s)	25.0				25.4	25.4	19.6		19.6			

Lanes, Volumes, Timings

65: I-49 NB Ramp & 163rd St./163rd St

07/10/2020

Lane Group	Ø5	Ø6	Ø7
Lane Configurations			
Traffic Volume (vph)			
Future Volume (vph)			
Ideal Flow (vphpl)			
Storage Length (ft)			
Storage Lanes			
Taper Length (ft)			
Lane Util. Factor			
Frt			
Flt Protected			
Satd. Flow (prot)			
Flt Permitted			
Satd. Flow (perm)			
Right Turn on Red			
Satd. Flow (RTOR)			
Link Speed (mph)			
Link Distance (ft)			
Travel Time (s)			
Peak Hour Factor			
Adj. Flow (vph)			
Shared Lane Traffic (%)			
Lane Group Flow (vph)			
Enter Blocked Intersection			
Lane Alignment			
Median Width(ft)			
Link Offset(ft)			
Crosswalk Width(ft)			
Two way Left Turn Lane			
Headway Factor			
Turning Speed (mph)			
Number of Detectors			
Detector Template			
Leading Detector (ft)			
Trailing Detector (ft)			
Detector 1 Position(ft)			
Detector 1 Size(ft)			
Detector 1 Type			
Detector 1 Channel			
Detector 1 Extend (s)			
Detector 1 Queue (s)			
Detector 1 Delay (s)			
Turn Type			
Protected Phases	5	6	7
Permitted Phases			
Detector Phase			
Switch Phase			
Minimum Initial (s)	10.0	12.0	6.0
Minimum Split (s)	15.7	17.7	12.8
Total Split (s)	18.3	32.1	19.6

**Attachment E-4 – Synchro Analysis
2023 AM**

Lanes, Volumes, Timings

65: I-49 NB Ramp & 163rd St./163rd St

07/10/2020

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Total Split (%)	35.7%				36.3%			28.0%			28.0%	
Maximum Green (s)	19.2				19.6			12.8			12.8	
Yellow Time (s)	3.6				3.6			3.6			3.6	
All-Red Time (s)	2.2				2.2			3.2			3.2	
Lost Time Adjust (s)	0.0				0.0			0.0			0.0	
Total Lost Time (s)	5.8				5.8			6.8			6.8	
Lead/Lag	Lead				Lag			Lag				
Lead-Lag Optimize?	Yes				Yes			Yes				
Vehicle Extension (s)	4.0				4.0			4.0			4.0	
Recall Mode	None				Min			None			None	
Act Effect Green (s)	19.2		44.6		19.6		19.6		12.8		12.8	
Actuated g/C Ratio	0.27		0.64		0.28		0.28		0.18		0.18	
v/c Ratio	0.93		0.17		0.68		0.89		0.89		0.46	
Control Delay	30.7		3.1		25.4		24.8		59.4		7.3	
Queue Delay	0.0		0.0		0.0		0.0		0.0		0.0	
Total Delay	30.7		3.1		25.4		24.8		59.4		7.3	
LOS	C		A		C		C		E		A	
Approach Delay			22.3				25.1				37.1	
Approach LOS			C				C				D	

Intersection Summary

Area Type: Other

Cycle Length: 70

Actuated Cycle Length: 70

Natural Cycle: 70

Control Type: Actuated-Uncoordinated

Maximum v/c Ratio: 0.93

Intersection Signal Delay: 25.9

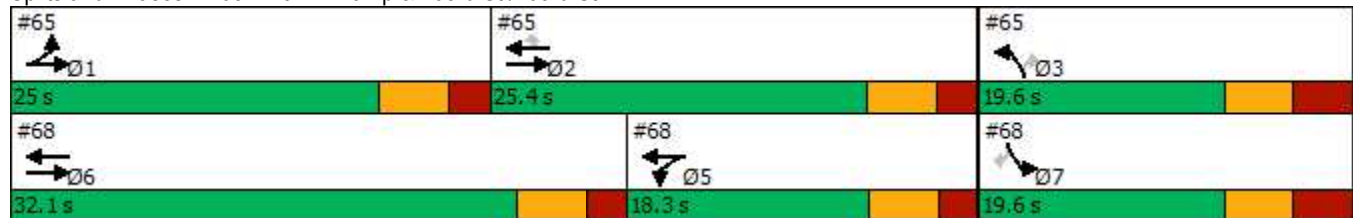
Intersection LOS: C

Intersection Capacity Utilization 84.5%

ICU Level of Service E

Analysis Period (min) 15

Splits and Phases: 65: I-49 NB Ramp & 163rd St./163rd St



Lanes, Volumes, Timings

65: I-49 NB Ramp & 163rd St./163rd St

07/10/2020

Lane Group	Ø5	Ø6	Ø7
Total Split (%)	26%	46%	28%
Maximum Green (s)	12.6	26.4	12.8
Yellow Time (s)	3.6	3.6	3.6
All-Red Time (s)	2.1	2.1	3.2
Lost Time Adjust (s)			
Total Lost Time (s)			
Lead/Lag	Lag	Lead	
Lead-Lag Optimize?	Yes	Yes	
Vehicle Extension (s)	4.0	4.0	4.0
Recall Mode	None	Min	None
Act Effect Green (s)			
Actuated g/C Ratio			
v/c Ratio			
Control Delay			
Queue Delay			
Total Delay			
LOS			
Approach Delay			
Approach LOS			
Intersection Summary			

**Attachment E-4 – Synchro Analysis
2023 AM**

Lanes, Volumes, Timings

68: I-49 SB Ramp & 163rd St/163rd St.

07/10/2020

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	689	34	87	818	0	0	0	0	300	0	321
Future Volume (vph)	0	689	34	87	818	0	0	0	0	300	0	321
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	390		0	0		0	0			285		340
Storage Lanes	2		0	1		0	0			1		1
Taper Length (ft)	110			0			0			120		
Lane Util. Factor	1.00	0.86	0.86	1.00	0.95	1.00	1.00	1.00	1.00	0.97	1.00	1.00
Frt		0.993										0.850
Flt Protected				0.950						0.950		
Satd. Flow (prot)	0	6363	0	1770	3539	0	0	0	0	3433	0	1583
Flt Permitted				0.950						0.950		
Satd. Flow (perm)	0	6363	0	1770	3539	0	0	0	0	3433	0	1583
Right Turn on Red			Yes			Yes				Yes		Yes
Satd. Flow (RTOR)		16										223
Link Speed (mph)		35			35			40			40	
Link Distance (ft)		628			335			662			1290	
Travel Time (s)		12.2			6.5			11.3			22.0	
Peak Hour Factor	0.92	0.79	0.78	0.60	0.78	0.92	0.92	0.92	0.92	0.91	0.92	0.89
Adj. Flow (vph)	0	872	44	145	1049	0	0	0	0	330	0	361
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	916	0	145	1049	0	0	0	0	330	0	361
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Right	Left	Right
Median Width(ft)		20			20			24			24	
Link Offset(ft)		0			0			0			0	
Crosswalk Width(ft)		16			16			16			16	
Two way Left Turn Lane												
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Turning Speed (mph)	15		9	15		9	15			9	15	9
Number of Detectors		1		1	1					1		1
Detector Template		Thru		Left	Thru					Left		Right
Leading Detector (ft)		30		30	30					30		30
Trailing Detector (ft)		0		0	0					0		0
Detector 1 Position(ft)		0		0	0					0		0
Detector 1 Size(ft)		30		30	30					30		30
Detector 1 Type		Cl+Ex		Cl+Ex	Cl+Ex					Cl+Ex		Cl+Ex
Detector 1 Channel												
Detector 1 Extend (s)		0.0		0.0	0.0					0.0		0.0
Detector 1 Queue (s)		0.0		0.0	0.0					0.0		0.0
Detector 1 Delay (s)		0.0		0.0	0.0					0.0		0.0
Turn Type		NA		Prot	NA					Prot		Perm
Protected Phases		6		5	5 6					7		
Permitted Phases												7
Detector Phase		6		5	5 6					7		7
Switch Phase												
Minimum Initial (s)		12.0		10.0						6.0		6.0
Minimum Split (s)		17.7		15.7						12.8		12.8
Total Split (s)		32.1		18.3						19.6		19.6

Lanes, Volumes, Timings

68: I-49 SB Ramp & 163rd St/163rd St.

07/10/2020

Lane Group	Ø1	Ø2	Ø3
Lane Configurations			
Traffic Volume (vph)			
Future Volume (vph)			
Ideal Flow (vphpl)			
Storage Length (ft)			
Storage Lanes			
Taper Length (ft)			
Lane Util. Factor			
Frt			
Flt Protected			
Satd. Flow (prot)			
Flt Permitted			
Satd. Flow (perm)			
Right Turn on Red			
Satd. Flow (RTOR)			
Link Speed (mph)			
Link Distance (ft)			
Travel Time (s)			
Peak Hour Factor			
Adj. Flow (vph)			
Shared Lane Traffic (%)			
Lane Group Flow (vph)			
Enter Blocked Intersection			
Lane Alignment			
Median Width(ft)			
Link Offset(ft)			
Crosswalk Width(ft)			
Two way Left Turn Lane			
Headway Factor			
Turning Speed (mph)			
Number of Detectors			
Detector Template			
Leading Detector (ft)			
Trailing Detector (ft)			
Detector 1 Position(ft)			
Detector 1 Size(ft)			
Detector 1 Type			
Detector 1 Channel			
Detector 1 Extend (s)			
Detector 1 Queue (s)			
Detector 1 Delay (s)			
Turn Type			
Protected Phases	1	2	3
Permitted Phases			
Detector Phase			
Switch Phase			
Minimum Initial (s)	6.0	12.0	6.0
Minimum Split (s)	11.8	17.8	12.8
Total Split (s)	25.0	25.4	19.6

**Attachment E-4 – Synchro Analysis
2023 AM**

Lanes, Volumes, Timings

68: I-49 SB Ramp & 163rd St/163rd St.

07/10/2020

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Total Split (%)		45.9%		26.1%						28.0%		28.0%
Maximum Green (s)		26.4		12.6						12.8		12.8
Yellow Time (s)		3.6		3.6						3.6		3.6
All-Red Time (s)		2.1		2.1						3.2		3.2
Lost Time Adjust (s)		0.0		0.0						0.0		0.0
Total Lost Time (s)		5.7		5.7						6.8		6.8
Lead/Lag		Lead		Lag								
Lead-Lag Optimize?		Yes		Yes								
Vehicle Extension (s)		4.0		4.0						4.0		4.0
Recall Mode		Min		None						None		None
Act Effect Green (s)		25.2		13.8	44.7					12.8		12.8
Actuated g/C Ratio		0.36		0.20	0.64					0.18		0.18
v/c Ratio		0.40		0.42	0.46					0.53		0.77
Control Delay		16.8		18.6	8.7					29.3		23.5
Queue Delay		0.0		0.0	0.3					0.0		0.0
Total Delay		16.8		18.6	9.0					29.3		23.5
LOS		B		B	A					C		C
Approach Delay		16.8			10.2						26.3	
Approach LOS		B			B						C	

Intersection Summary

Area Type: Other

Cycle Length: 70

Actuated Cycle Length: 70

Natural Cycle: 70

Control Type: Actuated-Uncoordinated

Maximum v/c Ratio: 0.93

Intersection Signal Delay: 16.3

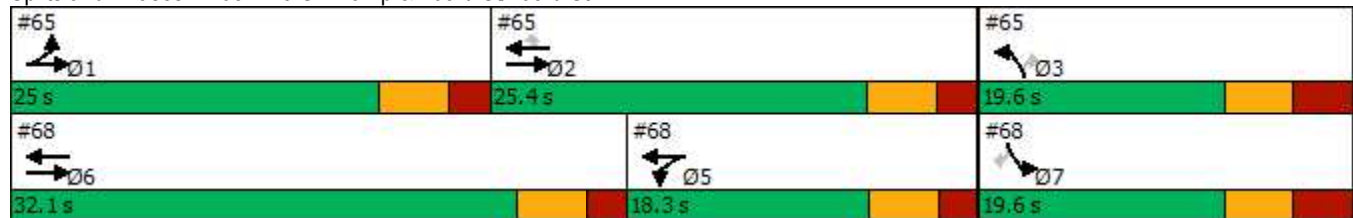
Intersection LOS: B

Intersection Capacity Utilization 84.5%

ICU Level of Service E

Analysis Period (min) 15

Splits and Phases: 68: I-49 SB Ramp & 163rd St/163rd St.



Lanes, Volumes, Timings

68: I-49 SB Ramp & 163rd St/163rd St.

07/10/2020

Lane Group	Ø1	Ø2	Ø3
Total Split (%)	36%	36%	28%
Maximum Green (s)	19.2	19.6	12.8
Yellow Time (s)	3.6	3.6	3.6
All-Red Time (s)	2.2	2.2	3.2
Lost Time Adjust (s)			
Total Lost Time (s)			
Lead/Lag	Lead	Lag	
Lead-Lag Optimize?	Yes	Yes	
Vehicle Extension (s)	4.0	4.0	4.0
Recall Mode	None	Min	None
Act Effect Green (s)			
Actuated g/C Ratio			
v/c Ratio			
Control Delay			
Queue Delay			
Total Delay			
LOS			
Approach Delay			
Approach LOS			
Intersection Summary			

**Attachment E-4 – Synchro Analysis
2023 PM**

**Lanes, Volumes, Timings
1: Harmon Drive & Route 58**

07/10/2020

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	40	1748	362	10	1381	53	191	27	29	69	28	105
Future Volume (vph)	40	1748	362	10	1381	53	191	27	29	69	28	105
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		0%			-1%			1%			3%	
Storage Length (ft)	90		0	205		135	200		40	130		55
Storage Lanes	1		0	1		0	1		0	1		0
Taper Length (ft)	25			25			25			25		
Lane Util. Factor	1.00	0.95	0.95	1.00	0.91	0.91	1.00	1.00	1.00	1.00	1.00	1.00
Fr't		0.974			0.994			0.921			0.881	
Flt Protected	0.950			0.950			0.950			0.950		
Satd. Flow (prot)	1752	3487	0	1814	5128	0	1796	1741	0	1778	1636	0
Flt Permitted	0.128			0.058			0.317			0.719		
Satd. Flow (perm)	236	3487	0	111	5128	0	599	1741	0	1346	1636	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		40			9			31			111	
Link Speed (mph)		40			40			45			45	
Link Distance (ft)		302			504			454			563	
Travel Time (s)		5.1			8.6			6.9			8.5	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Heavy Vehicles (%)	3%	1%	0%	0%	1%	2%	0%	0%	0%	0%	0%	1%
Adj. Flow (vph)	42	1840	381	11	1454	56	201	28	31	73	29	111
Shared Lane Traffic (%)												
Lane Group Flow (vph)	42	2221	0	11	1510	0	201	59	0	73	140	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(ft)		12			12			12			12	
Link Offset(ft)		0			0			0			0	
Crosswalk Width(ft)		16			16			16			16	
Two way Left Turn Lane												
Headway Factor	1.00	1.00	1.00	0.99	0.99	0.99	1.01	1.01	1.01	1.02	1.02	1.02
Turning Speed (mph)	15		9	15		9	15		9	15		9
Number of Detectors	1	1		1	1		1	1		1	1	
Detector Template	Left	Thru		Left	Thru		Left	Thru		Left	Thru	
Leading Detector (ft)	30	30		30	30		30	30		30	30	
Trailing Detector (ft)	0	0		0	0		0	0		0	0	
Detector 1 Position(ft)	0	0		0	0		0	0		0	0	
Detector 1 Size(ft)	30	30		30	30		30	30		30	30	
Detector 1 Type	Cl+Ex	Cl+Ex		Cl+Ex	Cl+Ex		Cl+Ex	Cl+Ex		Cl+Ex	Cl+Ex	
Detector 1 Channel												
Detector 1 Extend (s)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Detector 1 Queue (s)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Detector 1 Delay (s)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Turn Type	D.P+P	NA		D.P+P	NA		pm+pt	NA		pm+pt	NA	
Protected Phases	1	6		5	2		7	4		3	8	
Permitted Phases	2			6			4			8		
Detector Phase	1	6		5	2		7	4		3	8	
Switch Phase												
Minimum Initial (s)	5.0	10.0		5.0	10.0		5.0	5.0		4.0	5.0	

**Attachment E-4 – Synchro Analysis
2023 PM**

**Lanes, Volumes, Timings
1: Harmon Drive & Route 58**

07/10/2020

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Minimum Split (s)	11.0	15.6		11.0	15.6		11.2	12.0		11.0	12.0	
Total Split (s)	11.0	71.8		11.0	71.8		15.2	16.2		11.0	12.0	
Total Split (%)	10.0%	65.3%		10.0%	65.3%		13.8%	14.7%		10.0%	10.9%	
Maximum Green (s)	5.4	66.2		5.4	66.2		9.4	10.4		5.2	6.2	
Yellow Time (s)	3.6	3.6		3.6	3.6		4.2	4.2		4.2	4.2	
All-Red Time (s)	2.0	2.0		2.0	2.0		1.6	1.6		1.6	1.6	
Lost Time Adjust (s)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Total Lost Time (s)	5.6	5.6		5.6	5.6		5.8	5.8		5.8	5.8	
Lead/Lag	Lead	Lead		Lag	Lag		Lead	Lag		Lead	Lag	
Lead-Lag Optimize?	Yes	Yes		Yes	Yes		Yes	Yes		Yes	Yes	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	4.0		3.0	4.0	
Recall Mode	None	C-Max		None	C-Max		None	None		None	None	
Walk Time (s)		7.0			7.0							
Flash Dont Walk (s)		16.0			21.0							
Pedestrian Calls (#/hr)		0			0							
Act Effect Green (s)	73.8	75.0		76.1	70.6		20.1	12.6		11.4	6.2	
Actuated g/C Ratio	0.67	0.68		0.69	0.64		0.18	0.11		0.10	0.06	
v/c Ratio	0.18	0.93		0.07	0.46		0.95	0.26		0.46	0.71	
Control Delay	3.9	14.7		7.4	11.1		93.0	29.4		48.5	35.7	
Queue Delay	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Total Delay	3.9	14.7		7.4	11.1		93.0	29.4		48.5	35.7	
LOS	A	B		A	B		F	C		D	D	
Approach Delay		14.5			11.0			78.6			40.1	
Approach LOS		B			B			E			D	

Intersection Summary

Area Type: Other

Cycle Length: 110

Actuated Cycle Length: 110

Offset: 103 (94%), Referenced to phase 2:EBWB and 6:EBWB, Start of 1st Green

Natural Cycle: 120

Control Type: Actuated-Coordinated

Maximum v/c Ratio: 0.95

Intersection Signal Delay: 18.4

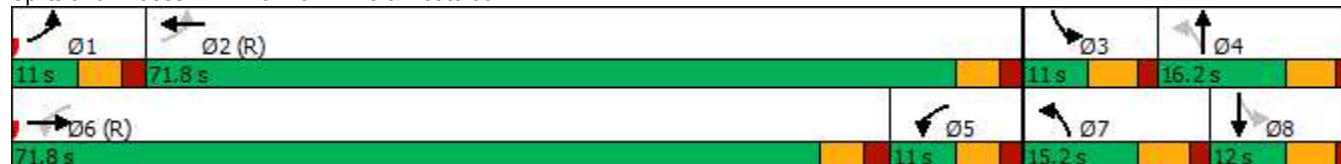
Intersection LOS: B

Intersection Capacity Utilization 92.7%

ICU Level of Service F

Analysis Period (min) 15

Splits and Phases: 1: Harmon Drive & Route 58



**Attachment E-4 – Synchro Analysis
2023 PM**

**Lanes, Volumes, Timings
2: I-49 NB Ramp & Route 58**

07/10/2020

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		 			 							
Traffic Volume (vph)	179	2009	0	0	974	703	142	0	141	0	0	0
Future Volume (vph)	179	2009	0	0	974	703	142	0	141	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		0%			0%			1%			0%	
Storage Length (ft)	230		0	0		0	331		150	0		0
Storage Lanes	1		0	0		1	0		1	0		0
Taper Length (ft)	150			0			25			0		
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt						0.850			0.850			
Flt Protected	0.950						0.950					
Satd. Flow (prot)	1805	3574	0	0	3574	1599	1744	0	1591	0	0	0
Flt Permitted	0.238						0.950					
Satd. Flow (perm)	452	3574	0	0	3574	1599	1744	0	1591	0	0	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)						493			75			
Link Speed (mph)		40			40			40			40	
Link Distance (ft)		594			302			1064			450	
Travel Time (s)		10.1			5.1			18.1			7.7	
Peak Hour Factor	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Heavy Vehicles (%)	0%	1%	0%	0%	1%	1%	3%	0%	1%	0%	0%	0%
Adj. Flow (vph)	186	2093	0	0	1015	732	148	0	147	0	0	0
Shared Lane Traffic (%)												
Lane Group Flow (vph)	186	2093	0	0	1015	732	148	0	147	0	0	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(ft)		12			12			12			12	
Link Offset(ft)		0			0			0			0	
Crosswalk Width(ft)		16			16			16			16	
Two way Left Turn Lane												
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.01	1.01	1.01	1.00	1.00	1.00
Turning Speed (mph)	15		9	15		9	15		9	15		9
Number of Detectors	1	1			1	1	1		1			
Detector Template	Left	Thru			Thru	Right	Left		Right			
Leading Detector (ft)	30	30			30	30	30		30			
Trailing Detector (ft)	0	0			0	0	0		0			
Detector 1 Position(ft)	0	0			0	0	0		0			
Detector 1 Size(ft)	30	30			30	30	30		30			
Detector 1 Type	Cl+Ex	Cl+Ex			Cl+Ex	Cl+Ex	Cl+Ex		Cl+Ex			
Detector 1 Channel												
Detector 1 Extend (s)	0.0	0.0			0.0	0.0	0.0		0.0			
Detector 1 Queue (s)	0.0	0.0			0.0	0.0	0.0		0.0			
Detector 1 Delay (s)	0.0	0.0			0.0	0.0	0.0		0.0			
Turn Type	D.P+P	NA			NA	Free	Perm		Perm			
Protected Phases	1	6			2							
Permitted Phases	2					Free	7		7			
Detector Phase	1	6			2		7		7			
Switch Phase												
Minimum Initial (s)	5.0	10.0			10.0		8.0		8.0			

**Attachment E-4 – Synchro Analysis
2023 PM**

**Lanes, Volumes, Timings
2: I-49 NB Ramp & Route 58**

07/10/2020

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Minimum Split (s)	12.0	15.3			21.3		15.0		15.0			
Total Split (s)	15.0	87.0			72.0		23.0		23.0			
Total Split (%)	13.6%	79.1%			65.5%		20.9%		20.9%			
Maximum Green (s)	9.7	81.7			66.7		17.1		17.1			
Yellow Time (s)	3.6	3.6			3.6		3.9		3.9			
All-Red Time (s)	1.7	1.7			1.7		2.0		2.0			
Lost Time Adjust (s)	0.0	0.0			0.0		0.0		0.0			
Total Lost Time (s)	5.3	5.3			5.3		5.9		5.9			
Lead/Lag	Lead				Lag							
Lead-Lag Optimize?	Yes				Yes							
Vehicle Extension (s)	3.0	3.0			3.0		3.0		3.0			
Recall Mode	None	C-Max			C-Max		None		None			
Walk Time (s)					5.0							
Flash Dont Walk (s)					11.0							
Pedestrian Calls (#/hr)					0							
Act Effct Green (s)	79.5	84.8			71.2	110.0	14.0		14.0			
Actuated g/C Ratio	0.72	0.77			0.65	1.00	0.13		0.13			
v/c Ratio	0.43	0.76			0.44	0.46	0.67		0.55			
Control Delay	2.8	4.7			5.7	2.5	60.3		30.2			
Queue Delay	0.0	1.2			0.1	0.0	0.0		1.0			
Total Delay	2.8	5.9			5.8	2.5	60.3		31.2			
LOS	A	A			A	A	E		C			
Approach Delay	5.6				4.4				45.8			
Approach LOS	A				A				D			

Intersection Summary

Area Type: Other

Cycle Length: 110

Actuated Cycle Length: 110

Offset: 101 (92%), Referenced to phase 2:EBWB and 6:EBT, Start of 1st Green

Natural Cycle: 60

Control Type: Actuated-Coordinated

Maximum v/c Ratio: 0.76

Intersection Signal Delay: 7.9

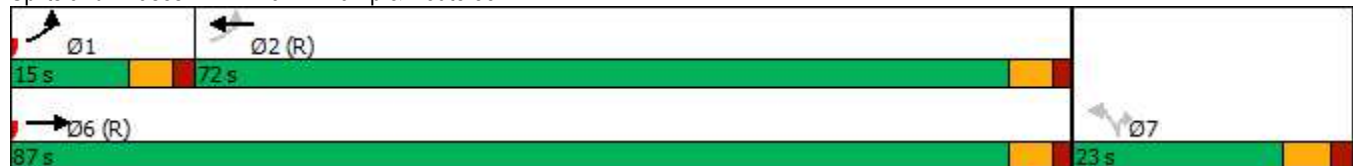
Intersection LOS: A

Intersection Capacity Utilization 111.3%

ICU Level of Service H

Analysis Period (min) 15

Splits and Phases: 2: I-49 NB Ramp & Route 58



**Attachment E-4 – Synchro Analysis
2023 PM**

**Lanes, Volumes, Timings
3: I-49 SB Ramp & Route 58**

07/10/2020

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	1091	281	143	973	0	0	0	0	1097	0	259
Future Volume (vph)	0	1091	281	143	973	0	0	0	0	1097	0	259
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		1%			0%			0%			2%	
Storage Length (ft)	0		0	140		0	0		0	0		350
Storage Lanes	0		0	1		0	0		0	2		1
Taper Length (ft)	0			150			0			0		
Lane Util. Factor	1.00	0.95	0.95	1.00	0.95	1.00	1.00	1.00	1.00	0.97	1.00	1.00
Frt		0.969										0.850
Flt Protected				0.950						0.950		
Satd. Flow (prot)	0	3466	0	1770	3574	0	0	0	0	3432	0	1567
Flt Permitted				0.083						0.950		
Satd. Flow (perm)	0	3466	0	155	3574	0	0	0	0	3432	0	1567
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		37										99
Link Speed (mph)		40			40			40			40	
Link Distance (ft)		315			594			338			1081	
Travel Time (s)		5.4			10.1			5.8			18.4	
Peak Hour Factor	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Heavy Vehicles (%)	0%	0%	2%	2%	1%	0%	0%	0%	0%	1%	0%	2%
Adj. Flow (vph)	0	1113	287	146	993	0	0	0	0	1119	0	264
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	1400	0	146	993	0	0	0	0	1119	0	264
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(ft)		12			12			24			24	
Link Offset(ft)		0			0			0			0	
Crosswalk Width(ft)		16			16			16			16	
Two way Left Turn Lane												
Headway Factor	1.01	1.01	1.01	1.00	1.00	1.00	1.00	1.00	1.00	1.01	1.01	1.01
Turning Speed (mph)	15		9	15		9	15		9	15		9
Number of Detectors		1		1	1					1		1
Detector Template		Thru		Left	Thru					Left		Right
Leading Detector (ft)		30		30	30					30		30
Trailing Detector (ft)		0		0	0					0		0
Detector 1 Position(ft)		0		0	0					0		0
Detector 1 Size(ft)		30		30	30					30		30
Detector 1 Type		Cl+Ex		Cl+Ex	Cl+Ex					Cl+Ex		Cl+Ex
Detector 1 Channel												
Detector 1 Extend (s)		0.0		0.0	0.0					0.0		0.0
Detector 1 Queue (s)		0.0		0.0	0.0					0.0		0.0
Detector 1 Delay (s)		0.0		0.0	0.0					0.0		0.0
Turn Type		NA		D,P+P	NA					Prot		Prot
Protected Phases		6		5	2					3		3
Permitted Phases				6								
Detector Phase		6		5	2					3		3
Switch Phase												
Minimum Initial (s)		10.0		6.0	10.0					8.0		8.0

**Attachment E-4 – Synchro Analysis
2023 PM**

**Lanes, Volumes, Timings
3: I-49 SB Ramp & Route 58**

07/10/2020

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Minimum Split (s)		21.6		12.0	21.6					15.0		15.0
Total Split (s)		54.0		12.0	66.0					44.0		44.0
Total Split (%)		49.1%		10.9%	60.0%					40.0%		40.0%
Maximum Green (s)		48.4		6.4	60.4					38.1		38.1
Yellow Time (s)		3.6		3.6	3.6					3.9		3.9
All-Red Time (s)		2.0		2.0	2.0					2.0		2.0
Lost Time Adjust (s)		0.0		0.0	0.0					0.0		0.0
Total Lost Time (s)		5.6		5.6	5.6					5.9		5.9
Lead/Lag		Lead		Lag								
Lead-Lag Optimize?		Yes		Yes								
Vehicle Extension (s)		5.0		5.0	3.0					6.0		6.0
Recall Mode		C-Max		None	C-Max					None		None
Walk Time (s)		7.0			7.0							
Flash Dont Walk (s)		21.0			10.0							
Pedestrian Calls (#/hr)		0			0							
Act Effect Green (s)		48.4		54.8	60.4					38.1		38.1
Actuated g/C Ratio		0.44		0.50	0.55					0.35		0.35
v/c Ratio		0.91		0.85	0.51					0.94		0.43
Control Delay		28.9		69.4	10.8					50.9		19.4
Queue Delay		1.3		0.0	0.0					0.0		0.0
Total Delay		30.2		69.4	10.8					50.9		19.4
LOS		C		E	B					D		B
Approach Delay		30.2			18.3						44.9	
Approach LOS		C			B						D	

Intersection Summary

Area Type: Other

Cycle Length: 110

Actuated Cycle Length: 110

Offset: 14 (13%), Referenced to phase 2:WBT and 6:EBWB, Start of 1st Green

Natural Cycle: 90

Control Type: Actuated-Coordinated

Maximum v/c Ratio: 0.94

Intersection Signal Delay: 31.9

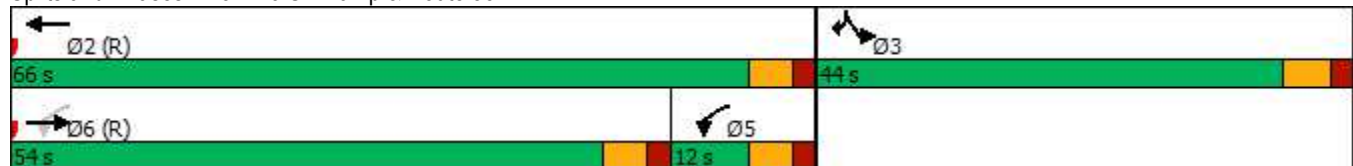
Intersection LOS: C

Intersection Capacity Utilization 111.3%

ICU Level of Service H

Analysis Period (min) 15

Splits and Phases: 3: I-49 SB Ramp & Route 58



**Attachment E-4 – Synchro Analysis
2023 PM**

**Lanes, Volumes, Timings
4: Peculiar Dr & Route 58**

07/10/2020

						
Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↑↑		↵	↑↑	↵	
Traffic Volume (vph)	1301	40	75	1157	28	71
Future Volume (vph)	1301	40	75	1157	28	71
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Grade (%)	2%			-1%	2%	
Storage Length (ft)		0	140		307	60
Storage Lanes		0	1		0	0
Taper Length (ft)			25		25	
Lane Util. Factor	0.95	0.95	1.00	0.95	1.00	1.00
Frt	0.996				0.903	
Flt Protected			0.950		0.986	
Satd. Flow (prot)	3525	0	1814	3592	1651	0
Flt Permitted			0.147		0.986	
Satd. Flow (perm)	3525	0	281	3592	1651	0
Right Turn on Red		Yes				Yes
Satd. Flow (RTOR)	6				75	
Link Speed (mph)	40			40	45	
Link Distance (ft)	881			315	346	
Travel Time (s)	15.0			5.4	5.2	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Heavy Vehicles (%)	1%	0%	0%	1%	0%	2%
Adj. Flow (vph)	1369	42	79	1218	29	75
Shared Lane Traffic (%)						
Lane Group Flow (vph)	1411	0	79	1218	104	0
Enter Blocked Intersection	No	No	No	No	No	No
Lane Alignment	Left	Right	Left	Left	Left	Right
Median Width(ft)	12			12	12	
Link Offset(ft)	0			0	0	
Crosswalk Width(ft)	16			16	16	
Two way Left Turn Lane						
Headway Factor	1.01	1.01	0.99	0.99	1.01	1.01
Turning Speed (mph)		9	15		15	9
Number of Detectors	1		1	1	1	
Detector Template	Thru		Left	Thru	Left	
Leading Detector (ft)	30		30	30	30	
Trailing Detector (ft)	0		0	0	0	
Detector 1 Position(ft)	0		0	0	0	
Detector 1 Size(ft)	30		30	30	30	
Detector 1 Type	Cl+Ex		Cl+Ex	Cl+Ex	Cl+Ex	
Detector 1 Channel						
Detector 1 Extend (s)	0.0		0.0	0.0	0.0	
Detector 1 Queue (s)	0.0		0.0	0.0	0.0	
Detector 1 Delay (s)	0.0		0.0	0.0	0.0	
Turn Type	NA		D.P+P	NA	Prot	
Protected Phases	6		5	2	7	
Permitted Phases			6			
Detector Phase	6		5	2	7	
Switch Phase						
Minimum Initial (s)	10.0		6.0	10.0	8.0	

Lanes, Volumes, Timings
4: Peculiar Dr & Route 58

07/10/2020

	→	↘	↙	←	↖	↗
Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Minimum Split (s)	21.1		11.1	21.1	15.0	
Total Split (s)	76.0		14.0	90.0	20.0	
Total Split (%)	69.1%		12.7%	81.8%	18.2%	
Maximum Green (s)	70.9		8.9	84.9	14.5	
Yellow Time (s)	3.6		3.6	3.6	3.6	
All-Red Time (s)	1.5		1.5	1.5	1.9	
Lost Time Adjust (s)	0.0		0.0	0.0	0.0	
Total Lost Time (s)	5.1		5.1	5.1	5.5	
Lead/Lag	Lead		Lag			
Lead-Lag Optimize?	Yes		Yes			
Vehicle Extension (s)	3.0		3.0	3.0	3.0	
Recall Mode	C-Max		None	C-Max	None	
Walk Time (s)	7.0					
Flash Dont Walk (s)	11.0					
Pedestrian Calls (#/hr)	0					
Act Effect Green (s)	79.0		86.1	90.2	9.2	
Actuated g/C Ratio	0.72		0.78	0.82	0.08	
v/c Ratio	0.56		0.24	0.41	0.50	
Control Delay	9.1		2.8	0.9	26.0	
Queue Delay	0.1		0.0	0.1	0.1	
Total Delay	9.2		2.8	1.0	26.0	
LOS	A		A	A	C	
Approach Delay	9.2			1.1	26.0	
Approach LOS	A			A	C	

Intersection Summary

Area Type: Other

Cycle Length: 110

Actuated Cycle Length: 110

Offset: 19 (17%), Referenced to phase 2:WBT and 6:EBWB, Start of 1st Green

Natural Cycle: 60

Control Type: Actuated-Coordinated

Maximum v/c Ratio: 0.56

Intersection Signal Delay: 6.1

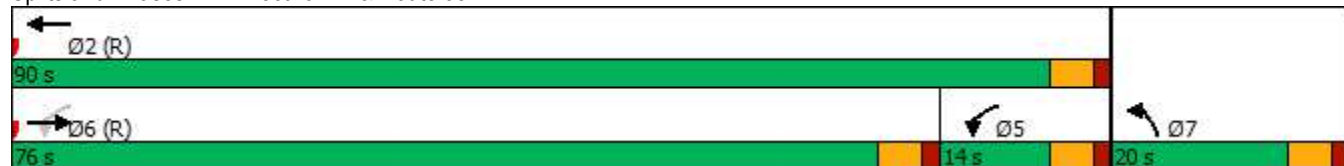
Intersection LOS: A

Intersection Capacity Utilization 62.0%

ICU Level of Service B

Analysis Period (min) 15

Splits and Phases: 4: Peculiar Dr & Route 58



**Attachment E-4 – Synchro Analysis
2023 PM**

Lanes, Volumes, Timings

30: I-49 SB Ramp & N. Cass Parkway

07/10/2020

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑↑↑	↑	↑	↑↑					↑↑		↑
Traffic Volume (vph)	0	113	73	200	179	0	0	0	0	172	0	109
Future Volume (vph)	0	113	73	200	179	0	0	0	0	172	0	109
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	60		290	0		0	0		0	380		380
Storage Lanes	1		1	1		0	0		0	1		1
Taper Length (ft)	25			0			0			25		
Lane Util. Factor	1.00	0.91	1.00	1.00	0.95	1.00	1.00	1.00	1.00	0.97	1.00	1.00
Frt			0.850									0.850
Flt Protected				0.950						0.950		
Satd. Flow (prot)	0	5085	1583	1770	3539	0	0	0	0	3433	0	1583
Flt Permitted				0.395						0.950		
Satd. Flow (perm)	0	5085	1583	736	3539	0	0	0	0	3433	0	1583
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)			179									192
Link Speed (mph)		45			45			40			40	
Link Distance (ft)		607			634			565			826	
Travel Time (s)		9.2			9.6			9.6			14.1	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	123	79	217	195	0	0	0	0	187	0	118
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	123	79	217	195	0	0	0	0	187	0	118
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(ft)		12			12			24			24	
Link Offset(ft)		0			0			0			0	
Crosswalk Width(ft)		16			16			16			16	
Two way Left Turn Lane												
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Turning Speed (mph)	15		9	15		9	15		9	15		9
Number of Detectors		2	1	1	2					1		1
Detector Template		Thru	Right	Left	Thru					Left		Right
Leading Detector (ft)		100	20	20	100					20		20
Trailing Detector (ft)		0	0	0	0					0		0
Detector 1 Position(ft)		0	0	0	0					0		0
Detector 1 Size(ft)		6	20	20	6					20		20
Detector 1 Type		Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex					Cl+Ex		Cl+Ex
Detector 1 Channel												
Detector 1 Extend (s)		0.0	0.0	0.0	0.0					0.0		0.0
Detector 1 Queue (s)		0.0	0.0	0.0	0.0					0.0		0.0
Detector 1 Delay (s)		0.0	0.0	0.0	0.0					0.0		0.0
Detector 2 Position(ft)		94			94							
Detector 2 Size(ft)		6			6							
Detector 2 Type		Cl+Ex			Cl+Ex							
Detector 2 Channel												
Detector 2 Extend (s)		0.0			0.0							
Turn Type		NA	Perm	pm+pt	NA					Prot		Perm
Protected Phases		4		3	8					5		
Permitted Phases			4	8								5

**Attachment E-4 – Synchro Analysis
2023 PM**

Lanes, Volumes, Timings

30: I-49 SB Ramp & N. Cass Parkway

07/10/2020

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Detector Phase		4	4	3	8					5		5
Switch Phase												
Minimum Initial (s)		10.0	10.0	7.0	10.0					7.0		7.0
Minimum Split (s)		21.6	21.6	12.5	21.2					12.7		12.7
Total Split (s)		22.0	22.0	13.0	35.0					15.0		15.0
Total Split (%)		44.0%	44.0%	26.0%	70.0%					30.0%		30.0%
Maximum Green (s)		15.7	15.7	7.5	29.8					9.3		9.3
Yellow Time (s)		4.8	4.8	4.1	4.1					4.0		4.0
All-Red Time (s)		1.5	1.5	1.4	1.1					1.7		1.7
Lost Time Adjust (s)		0.0	0.0	0.0	0.0					0.0		0.0
Total Lost Time (s)		6.3	6.3	5.5	5.2					5.7		5.7
Lead/Lag		Lag	Lag	Lead								
Lead-Lag Optimize?		Yes	Yes	Yes								
Vehicle Extension (s)		3.0	3.0	3.0	3.0					3.0		3.0
Recall Mode		Min	Min	None	Min					None		None
Act Effect Green (s)		8.0	8.0	21.0	19.8					20.3		20.3
Actuated g/C Ratio		0.16	0.16	0.42	0.40					0.41		0.41
v/c Ratio		0.15	0.20	0.46	0.14					0.13		0.16
Control Delay		17.0	1.1	7.1	2.1					13.3		1.4
Queue Delay		0.0	0.0	0.0	0.0					0.0		0.0
Total Delay		17.0	1.1	7.1	2.1					13.3		1.4
LOS		B	A	A	A					B		A
Approach Delay		10.8			4.8						8.7	
Approach LOS		B			A						A	

Intersection Summary

Area Type: Other

Cycle Length: 50

Actuated Cycle Length: 50

Offset: 22 (44%), Referenced to phase 2: and 6:, Start of Green

Natural Cycle: 50

Control Type: Actuated-Coordinated

Maximum v/c Ratio: 0.46

Intersection Signal Delay: 7.4

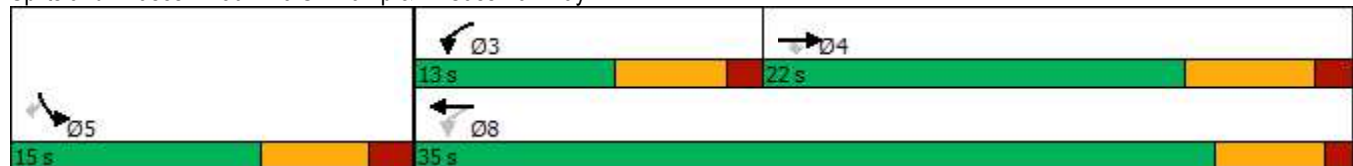
Intersection LOS: A

Intersection Capacity Utilization 39.8%

ICU Level of Service A

Analysis Period (min) 15

Splits and Phases: 30: I-49 SB Ramp & N. Cass Parkway



**Attachment E-4 – Synchro Analysis
2023 PM**

Lanes, Volumes, Timings

33: I-49 NB Ramp & N. Cass Parkway

07/10/2020

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		 			  							
Traffic Volume (vph)	69	216	0	0	309	296	70	0	160	0	0	0
Future Volume (vph)	69	216	0	0	309	296	70	0	160	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0		0	60		320	285		285	0		0
Storage Lanes	1		0	1		1	0		1	0		0
Taper Length (ft)	0			25			25			0		
Lane Util. Factor	1.00	0.95	1.00	1.00	0.91	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt						0.850			0.850			
Flt Protected	0.950						0.950					
Satd. Flow (prot)	1770	3539	0	0	5085	1583	1770	0	1583	0	0	0
Flt Permitted	0.308						0.950					
Satd. Flow (perm)	574	3539	0	0	5085	1583	1770	0	1583	0	0	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)						322			188			
Link Speed (mph)		45			45			40			40	
Link Distance (ft)		634			604			748			707	
Travel Time (s)		9.6			9.2			12.8			12.1	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	75	235	0	0	336	322	76	0	174	0	0	0
Shared Lane Traffic (%)												
Lane Group Flow (vph)	75	235	0	0	336	322	76	0	174	0	0	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(ft)		12			12			12			12	
Link Offset(ft)		0			0			0			0	
Crosswalk Width(ft)		16			0			16			16	
Two way Left Turn Lane												
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Turning Speed (mph)	15		9	15		9	15		9	15		9
Number of Detectors	1	2			2	1	1		1			
Detector Template	Left	Thru			Thru	Right	Left		Right			
Leading Detector (ft)	20	100			100	20	20		20			
Trailing Detector (ft)	0	0			0	0	0		0			
Detector 1 Position(ft)	0	0			0	0	0		0			
Detector 1 Size(ft)	20	6			6	20	20		20			
Detector 1 Type	Cl+Ex	Cl+Ex			Cl+Ex	Cl+Ex	Cl+Ex		Cl+Ex			
Detector 1 Channel												
Detector 1 Extend (s)	0.0	0.0			0.0	0.0	0.0		0.0			
Detector 1 Queue (s)	0.0	0.0			0.0	0.0	0.0		0.0			
Detector 1 Delay (s)	0.0	0.0			0.0	0.0	0.0		0.0			
Detector 2 Position(ft)		94			94							
Detector 2 Size(ft)		6			6							
Detector 2 Type		Cl+Ex			Cl+Ex							
Detector 2 Channel												
Detector 2 Extend (s)		0.0			0.0							
Turn Type	pm+pt	NA			NA	Free	Prot		Perm			
Protected Phases	3	8			4		5					
Permitted Phases	8					Free			5			

**Attachment E-4 – Synchro Analysis
2023 PM**

Lanes, Volumes, Timings

33: I-49 NB Ramp & N. Cass Parkway

07/10/2020

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Detector Phase	3	8			4		5		5			
Switch Phase												
Minimum Initial (s)	7.0	10.0			10.0		7.0		7.0			
Minimum Split (s)	13.1	20.0			20.0		12.4		12.4			
Total Split (s)	13.2	33.2			20.0		16.8		16.8			
Total Split (%)	26.4%	66.4%			40.0%		33.6%		33.6%			
Maximum Green (s)	7.1	27.7			14.6		11.4		11.4			
Yellow Time (s)	4.5	4.5			4.0		4.0		4.0			
All-Red Time (s)	1.6	1.0			1.4		1.4		1.4			
Lost Time Adjust (s)	0.0	0.0			0.0		0.0		0.0			
Total Lost Time (s)	6.1	5.5			5.4		5.4		5.4			
Lead/Lag	Lead				Lag							
Lead-Lag Optimize?	Yes				Yes							
Vehicle Extension (s)	3.0	3.0			3.0		3.0		3.0			
Recall Mode	None	Min			Min		None		None			
Act Effct Green (s)	17.1	16.2			8.1	50.0	24.0		24.0			
Actuated g/C Ratio	0.34	0.32			0.16	1.00	0.48		0.48			
v/c Ratio	0.20	0.21			0.41	0.20	0.09		0.20			
Control Delay	6.1	6.0			18.8	0.3	12.5		3.2			
Queue Delay	0.0	0.0			0.0	0.0	0.0		0.0			
Total Delay	6.1	6.0			18.8	0.3	12.5		3.2			
LOS	A	A			B	A	B		A			
Approach Delay		6.1			9.7			6.0				
Approach LOS		A			A			A				

Intersection Summary

Area Type: Other

Cycle Length: 50

Actuated Cycle Length: 50

Offset: 0 (0%), Referenced to phase 2: and 6:, Start of Green

Natural Cycle: 50

Control Type: Actuated-Coordinated

Maximum v/c Ratio: 0.41

Intersection Signal Delay: 8.0

Intersection LOS: A

Intersection Capacity Utilization 39.8%

ICU Level of Service A

Analysis Period (min) 15

Splits and Phases: 33: I-49 NB Ramp & N. Cass Parkway



**Attachment E-4 – Synchro Analysis
2023 PM**

Lanes, Volumes, Timings
65: I-49 NB Ramp & 163rd St

07/10/2020

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	583	783	0	0	466	251	151	0	98	0	0	0
Future Volume (vph)	583	783	0	0	466	251	151	0	98	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0		0	255		520	0		135	0		0
Storage Lanes	2		0	1		1	1		1	0		0
Taper Length (ft)	0			100			0			0		
Lane Util. Factor	0.97	0.95	1.00	1.00	0.91	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt						0.850			0.850			
Flt Protected	0.950						0.950					
Satd. Flow (prot)	3433	3539	0	0	5085	1583	1770	0	1583	0	0	0
Flt Permitted	0.950						0.950					
Satd. Flow (perm)	3433	3539	0	0	5085	1583	1770	0	1583	0	0	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)						292			217			
Link Speed (mph)		35			35			40			40	
Link Distance (ft)		335			765			923			376	
Travel Time (s)		6.5			14.9			15.7			6.4	
Peak Hour Factor	0.90	0.93	0.92	0.92	0.90	0.86	0.83	0.92	0.82	0.92	0.92	0.92
Adj. Flow (vph)	648	842	0	0	518	292	182	0	120	0	0	0
Shared Lane Traffic (%)												
Lane Group Flow (vph)	648	842	0	0	518	292	182	0	120	0	0	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(ft)		24			24			12			12	
Link Offset(ft)		0			0			0			0	
Crosswalk Width(ft)		16			16			16			16	
Two way Left Turn Lane												
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Turning Speed (mph)	15		9	15		9	15		9	15		9
Number of Detectors	1	1			1	1	1		1			
Detector Template	Left	Thru			Thru	Right	Left		Right			
Leading Detector (ft)	30	30			30	30	30		30			
Trailing Detector (ft)	0	0			0	0	0		0			
Detector 1 Position(ft)	0	0			0	0	0		0			
Detector 1 Size(ft)	30	30			30	30	30		30			
Detector 1 Type	Cl+Ex	Cl+Ex			Cl+Ex	Cl+Ex	Cl+Ex		Cl+Ex			
Detector 1 Channel												
Detector 1 Extend (s)	0.0	0.0			0.0	0.0	0.0		0.0			
Detector 1 Queue (s)	0.0	0.0			0.0	0.0	0.0		0.0			
Detector 1 Delay (s)	0.0	0.0			0.0	0.0	0.0		0.0			
Turn Type	Prot	NA			NA	Perm	Prot		Perm			
Protected Phases	1 4	1 2 4			2		3					
Permitted Phases						2			3			
Detector Phase	1	1 2			2	2	3		3			
Switch Phase												
Minimum Initial (s)					12.0	12.0	6.0		6.0			
Minimum Split (s)					17.6	17.6	12.8		12.8			
Total Split (s)					22.6	22.6	19.4		19.4			

Scenario 1 5:00 pm 10/08/2019 Baseline

Synchro 11 Report
Page 13

Lanes, Volumes, Timings
65: I-49 NB Ramp & 163rd St

07/10/2020

Lane Group	Ø1	Ø4	Ø5	Ø6	Ø7
Lane Configurations					
Traffic Volume (vph)					
Future Volume (vph)					
Ideal Flow (vphpl)					
Storage Length (ft)					
Storage Lanes					
Taper Length (ft)					
Lane Util. Factor					
Frt					
Flt Protected					
Satd. Flow (prot)					
Flt Permitted					
Satd. Flow (perm)					
Right Turn on Red					
Satd. Flow (RTOR)					
Link Speed (mph)					
Link Distance (ft)					
Travel Time (s)					
Peak Hour Factor					
Adj. Flow (vph)					
Shared Lane Traffic (%)					
Lane Group Flow (vph)					
Enter Blocked Intersection					
Lane Alignment					
Median Width(ft)					
Link Offset(ft)					
Crosswalk Width(ft)					
Two way Left Turn Lane					
Headway Factor					
Turning Speed (mph)					
Number of Detectors					
Detector Template					
Leading Detector (ft)					
Trailing Detector (ft)					
Detector 1 Position(ft)					
Detector 1 Size(ft)					
Detector 1 Type					
Detector 1 Channel					
Detector 1 Extend (s)					
Detector 1 Queue (s)					
Detector 1 Delay (s)					
Turn Type					
Protected Phases	1	4	5	6	7
Permitted Phases					
Detector Phase					
Switch Phase					
Minimum Initial (s)	6.0	4.0	10.0	12.0	6.0
Minimum Split (s)	11.5	16.0	15.6	17.5	12.8
Total Split (s)	15.4	17.6	15.9	22.1	37.0

**Attachment E-4 – Synchro Analysis
2023 PM**

Lanes, Volumes, Timings
65: I-49 NB Ramp & 163rd St

07/10/2020

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Total Split (%)					30.1%	30.1%	25.9%		25.9%			
Maximum Green (s)					17.0	17.0	12.6		12.6			
Yellow Time (s)					3.6	3.6	3.6		3.6			
All-Red Time (s)					2.0	2.0	3.2		3.2			
Lost Time Adjust (s)					0.0	0.0	0.0		0.0			
Total Lost Time (s)					5.6	5.6	6.8		6.8			
Lead/Lag					Lead	Lead	Lead		Lead			
Lead-Lag Optimize?					Yes	Yes	Yes		Yes			
Vehicle Extension (s)					4.0	4.0	4.0		4.0			
Recall Mode					Min	Min	None		None			
Act Effct Green (s)	23.5	50.9			16.3	16.3	11.7		11.7			
Actuated g/C Ratio	0.31	0.68			0.22	0.22	0.16		0.16			
v/c Ratio	0.60	0.35			0.47	0.51	0.66		0.28			
Control Delay	15.1	3.4			26.9	6.9	41.8		1.6			
Queue Delay	0.0	0.3			0.0	0.0	0.0		0.0			
Total Delay	15.1	3.7			26.9	6.9	41.8		1.6			
LOS	B	A			C	A	D		A			
Approach Delay		8.6			19.7			25.8				
Approach LOS		A			B			C				

Intersection Summary

Area Type: Other

Cycle Length: 75

Actuated Cycle Length: 74.9

Natural Cycle: 75

Control Type: Actuated-Uncoordinated

Maximum v/c Ratio: 0.97

Intersection Signal Delay: 14.1

Intersection LOS: B

Intersection Capacity Utilization 91.9%

ICU Level of Service F

Analysis Period (min) 15

Splits and Phases: 65: I-49 NB Ramp & 163rd St

#65 	#65 	#65 	#65 
22.6 s	15.4 s	19.4 s	17.6 s
#68 	#68 	#68 	
22.1 s	15.9 s	37 s	

**Lanes, Volumes, Timings
65: I-49 NB Ramp & 163rd St**

07/10/2020

Lane Group	Ø1	Ø4	Ø5	Ø6	Ø7
Total Split (%)	21%	23%	21%	29%	49%
Maximum Green (s)	9.9	12.1	10.3	16.6	30.2
Yellow Time (s)	3.6	3.6	3.6	3.6	3.6
All-Red Time (s)	1.9	1.9	2.0	1.9	3.2
Lost Time Adjust (s)					
Total Lost Time (s)					
Lead/Lag	Lag	Lag	Lag	Lead	
Lead-Lag Optimize?	Yes	Yes	Yes	Yes	
Vehicle Extension (s)	4.0	3.0	4.0	4.0	4.0
Recall Mode	None	Min	None	Min	None
Act Effect Green (s)					
Actuated g/C Ratio					
v/c Ratio					
Control Delay					
Queue Delay					
Total Delay					
LOS					
Approach Delay					
Approach LOS					
Intersection Summary					

**Attachment E-4 – Synchro Analysis
2023 PM**

Lanes, Volumes, Timings
68: I-49 SB Ramp & 163rd St

07/10/2020

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	892	215	130	487	0	0	0	0	474	0	674
Future Volume (vph)	0	892	215	130	487	0	0	0	0	474	0	674
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	390		0	0		0	0			285		340
Storage Lanes	2		0	1		0	0			1		1
Taper Length (ft)	110			0			0			120		
Lane Util. Factor	1.00	0.86	0.86	1.00	0.95	1.00	1.00	1.00	1.00	0.97	1.00	1.00
Frt		0.966										0.850
Flt Protected				0.950						0.950		
Satd. Flow (prot)	0	6190	0	1770	3539	0	0	0	0	3433	0	1583
Flt Permitted				0.950						0.950		
Satd. Flow (perm)	0	6190	0	1770	3539	0	0	0	0	3433	0	1583
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		92										212
Link Speed (mph)		35			35			40			40	
Link Distance (ft)		630			335			800			1291	
Travel Time (s)		12.3			6.5			13.6			22.0	
Peak Hour Factor	0.92	0.94	0.76	0.75	0.90	0.92	0.92	0.92	0.92	0.91	0.92	0.91
Adj. Flow (vph)	0	949	283	173	541	0	0	0	0	521	0	741
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	1232	0	173	541	0	0	0	0	521	0	741
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Right	Left	Right
Median Width(ft)		20			20			24			24	
Link Offset(ft)		0			0			0			0	
Crosswalk Width(ft)		16			16			16			16	
Two way Left Turn Lane												
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Turning Speed (mph)	15		9	15		9	15			9	15	9
Number of Detectors		1		1	1					1		1
Detector Template		Thru		Left	Thru					Left		Right
Leading Detector (ft)		30		30	30					30		30
Trailing Detector (ft)		0		0	0					0		0
Detector 1 Position(ft)		0		0	0					0		0
Detector 1 Size(ft)		30		30	30					30		30
Detector 1 Type		Cl+Ex		Cl+Ex	Cl+Ex					Cl+Ex		Cl+Ex
Detector 1 Channel												
Detector 1 Extend (s)		0.0		0.0	0.0					0.0		0.0
Detector 1 Queue (s)		0.0		0.0	0.0					0.0		0.0
Detector 1 Delay (s)		0.0		0.0	0.0					0.0		0.0
Turn Type		NA		Prot	NA					Prot		Perm
Protected Phases		6		5	5 6					7		
Permitted Phases												7
Detector Phase		6		5	5 6					7		7
Switch Phase												
Minimum Initial (s)		12.0		10.0						6.0		6.0
Minimum Split (s)		17.5		15.6						12.8		12.8
Total Split (s)		22.1		15.9						37.0		37.0

Lanes, Volumes, Timings
68: I-49 SB Ramp & 163rd St

07/10/2020

Lane Group	Ø1	Ø2	Ø3	Ø4
Lane Configurations				
Traffic Volume (vph)				
Future Volume (vph)				
Ideal Flow (vphpl)				
Storage Length (ft)				
Storage Lanes				
Taper Length (ft)				
Lane Util. Factor				
Frt				
Flt Protected				
Satd. Flow (prot)				
Flt Permitted				
Satd. Flow (perm)				
Right Turn on Red				
Satd. Flow (RTOR)				
Link Speed (mph)				
Link Distance (ft)				
Travel Time (s)				
Peak Hour Factor				
Adj. Flow (vph)				
Shared Lane Traffic (%)				
Lane Group Flow (vph)				
Enter Blocked Intersection				
Lane Alignment				
Median Width(ft)				
Link Offset(ft)				
Crosswalk Width(ft)				
Two way Left Turn Lane				
Headway Factor				
Turning Speed (mph)				
Number of Detectors				
Detector Template				
Leading Detector (ft)				
Trailing Detector (ft)				
Detector 1 Position(ft)				
Detector 1 Size(ft)				
Detector 1 Type				
Detector 1 Channel				
Detector 1 Extend (s)				
Detector 1 Queue (s)				
Detector 1 Delay (s)				
Turn Type				
Protected Phases	1	2	3	4
Permitted Phases				
Detector Phase				
Switch Phase				
Minimum Initial (s)	6.0	12.0	6.0	4.0
Minimum Split (s)	11.5	17.6	12.8	16.0
Total Split (s)	15.4	22.6	19.4	17.6

**Attachment E-4 – Synchro Analysis
2023 PM**

Lanes, Volumes, Timings
68: I-49 SB Ramp & 163rd St

07/10/2020

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Total Split (%)		29.5%		21.2%						49.3%		49.3%
Maximum Green (s)		16.6		10.3						30.2		30.2
Yellow Time (s)		3.6		3.6						3.6		3.6
All-Red Time (s)		1.9		2.0						3.2		3.2
Lost Time Adjust (s)		0.0		0.0						0.0		0.0
Total Lost Time (s)		5.5		5.6						6.8		6.8
Lead/Lag		Lead		Lag								
Lead-Lag Optimize?		Yes		Yes								
Vehicle Extension (s)		4.0		4.0						4.0		4.0
Recall Mode		Min		None						None		None
Act Effect Green (s)		16.6		10.2	32.3					30.2		30.2
Actuated g/C Ratio		0.22		0.14	0.43					0.40		0.40
v/c Ratio		0.85		0.71	0.35					0.38		0.97
Control Delay		33.1		41.7	8.1					16.8		44.0
Queue Delay		0.0		0.0	0.0					0.0		0.0
Total Delay		33.1		41.7	8.1					16.8		44.0
LOS		C		D	A					B		D
Approach Delay		33.1			16.3						32.8	
Approach LOS		C			B						C	

Intersection Summary

Area Type: Other

Cycle Length: 75

Actuated Cycle Length: 74.9

Natural Cycle: 75

Control Type: Actuated-Uncoordinated

Maximum v/c Ratio: 0.97

Intersection Signal Delay: 29.2

Intersection LOS: C

Intersection Capacity Utilization 91.9%

ICU Level of Service F

Analysis Period (min) 15

Splits and Phases: 68: I-49 SB Ramp & 163rd St

#65 	#65 	#65 	#65 
22.6 s	15.4 s	19.4 s	17.6 s
#68 	#68 	#68 	
22.1 s	15.9 s	37 s	

**Lanes, Volumes, Timings
68: I-49 SB Ramp & 163rd St**

07/10/2020

Lane Group	Ø1	Ø2	Ø3	Ø4
Total Split (%)	21%	30%	26%	23%
Maximum Green (s)	9.9	17.0	12.6	12.1
Yellow Time (s)	3.6	3.6	3.6	3.6
All-Red Time (s)	1.9	2.0	3.2	1.9
Lost Time Adjust (s)				
Total Lost Time (s)				
Lead/Lag	Lag	Lead	Lead	Lag
Lead-Lag Optimize?	Yes	Yes	Yes	Yes
Vehicle Extension (s)	4.0	4.0	4.0	3.0
Recall Mode	None	Min	None	Min
Act Effect Green (s)				
Actuated g/C Ratio				
v/c Ratio				
Control Delay				
Queue Delay				
Total Delay				
LOS				
Approach Delay				
Approach LOS				
Intersection Summary				

Attachment E-4 – Synchro Analysis
2045 AM

Lanes, Volumes, Timings
1: Harmon Drive & Route 58

07/10/2020

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	163	949	134	22	1596	53	504	26	23	47	15	69
Future Volume (vph)	163	949	134	22	1596	53	504	26	23	47	15	69
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		0%			-1%			1%			3%	
Storage Length (ft)	90		0	205		135	200		40	130		55
Storage Lanes	1		0	1		0	1		0	1		0
Taper Length (ft)	25			25			25			25		
Lane Util. Factor	1.00	0.95	0.95	1.00	0.91	0.91	1.00	1.00	1.00	1.00	1.00	1.00
Fr't		0.981			0.995			0.931			0.876	
Flt Protected	0.950			0.950			0.950			0.950		
Satd. Flow (prot)	1770	3430	0	1620	5088	0	1761	1696	0	1726	1613	0
Flt Permitted	0.137			0.112			0.360			0.724		
Satd. Flow (perm)	255	3430	0	191	5088	0	667	1696	0	1316	1613	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		19			6			23			70	
Link Speed (mph)		40			40			45			45	
Link Distance (ft)		302			504			437			563	
Travel Time (s)		5.1			8.6			6.6			8.5	
Peak Hour Factor	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Heavy Vehicles (%)	2%	3%	5%	12%	2%	0%	2%	1%	7%	3%	0%	2%
Adj. Flow (vph)	166	968	137	22	1629	54	514	27	23	48	15	70
Shared Lane Traffic (%)												
Lane Group Flow (vph)	166	1105	0	22	1683	0	514	50	0	48	85	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(ft)		12			12			12			12	
Link Offset(ft)		0			0			0			0	
Crosswalk Width(ft)		16			16			16			16	
Two way Left Turn Lane												
Headway Factor	1.00	1.00	1.00	0.99	0.99	0.99	1.01	1.01	1.01	1.02	1.02	1.02
Turning Speed (mph)	15		9	15		9	15		9	15		9
Number of Detectors	1	1		1	1		1	1		1	1	
Detector Template	Left	Thru		Left	Thru		Left	Thru		Left	Thru	
Leading Detector (ft)	30	30		30	30		30	30		30	30	
Trailing Detector (ft)	0	0		0	0		0	0		0	0	
Detector 1 Position(ft)	0	0		0	0		0	0		0	0	
Detector 1 Size(ft)	30	30		30	30		30	30		30	30	
Detector 1 Type	Cl+Ex	Cl+Ex		Cl+Ex	Cl+Ex		Cl+Ex	Cl+Ex		Cl+Ex	Cl+Ex	
Detector 1 Channel												
Detector 1 Extend (s)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Detector 1 Queue (s)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Detector 1 Delay (s)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Turn Type	D.P+P	NA		D.P+P	NA		pm+pt	NA		pm+pt	NA	
Protected Phases	1	6		5	2		7	4		3	8	
Permitted Phases	2			6			4			8		
Detector Phase	1	6		5	2		7	4		3	8	
Switch Phase												
Minimum Initial (s)	5.0	10.0		5.0	10.0		5.0	5.0		4.0	5.0	

Attachment E-4 – Synchro Analysis
2045 AM

Lanes, Volumes, Timings
1: Harmon Drive & Route 58

07/10/2020

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Minimum Split (s)	11.0	15.6		11.0	15.6		11.2	12.0		11.0	12.0	
Total Split (s)	11.0	38.0		11.0	38.0		29.0	30.0		11.0	12.0	
Total Split (%)	12.2%	42.2%		12.2%	42.2%		32.2%	33.3%		12.2%	13.3%	
Maximum Green (s)	5.4	32.4		5.4	32.4		23.2	24.2		5.2	6.2	
Yellow Time (s)	3.6	3.6		3.6	3.6		4.2	4.2		4.2	4.2	
All-Red Time (s)	2.0	2.0		2.0	2.0		1.6	1.6		1.6	1.6	
Lost Time Adjust (s)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Total Lost Time (s)	5.6	5.6		5.6	5.6		5.8	5.8		5.8	5.8	
Lead/Lag	Lag	Lag		Lead	Lead		Lead	Lag		Lead	Lag	
Lead-Lag Optimize?	Yes	Yes		Yes	Yes		Yes	Yes		Yes	Yes	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	4.0		3.0	4.0	
Recall Mode	None	C-Max		None	C-Max		None	None		None	None	
Walk Time (s)		7.0			7.0							
Flash Dont Walk (s)		16.0			21.0							
Pedestrian Calls (#/hr)		0			0							
Act Effect Green (s)	40.2	41.4		43.6	34.8		32.8	26.2		10.2	6.2	
Actuated g/C Ratio	0.45	0.46		0.48	0.39		0.36	0.29		0.11	0.07	
v/c Ratio	0.81	0.70		0.12	0.85		0.98	0.10		0.28	0.48	
Control Delay	46.2	13.6		14.0	31.5		62.2	16.3		24.8	23.7	
Queue Delay	0.0	0.6		0.0	0.0		0.0	0.0		0.0	0.0	
Total Delay	46.2	14.2		14.0	31.5		62.2	16.3		24.8	23.7	
LOS	D	B		B	C		E	B		C	C	
Approach Delay		18.4			31.3			58.1			24.1	
Approach LOS		B			C			E			C	

Intersection Summary

Area Type: Other

Cycle Length: 90

Actuated Cycle Length: 90

Offset: 82 (91%), Referenced to phase 2:EBWB and 6:EBWB, Start of 1st Green

Natural Cycle: 90

Control Type: Actuated-Coordinated

Maximum v/c Ratio: 0.98

Intersection Signal Delay: 30.7

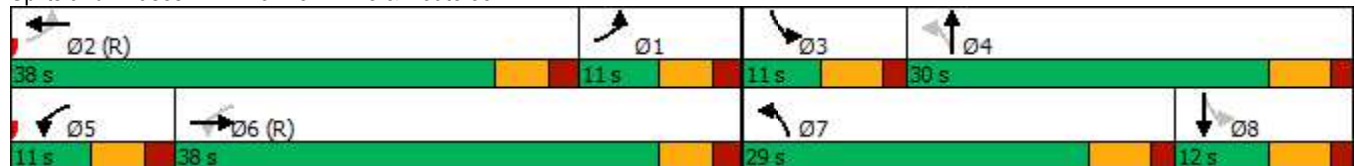
Intersection LOS: C

Intersection Capacity Utilization 89.8%

ICU Level of Service E

Analysis Period (min) 15

Splits and Phases: 1: Harmon Drive & Route 58



Attachment E-4 – Synchro Analysis
2045 AM

Lanes, Volumes, Timings
2: I-49 NB Ramp & Route 58

07/10/2020

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		 			 							
Traffic Volume (vph)	328	1002	0	0	725	1444	234	0	244	0	0	0
Future Volume (vph)	328	1002	0	0	725	1444	234	0	244	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		0%			0%			1%			0%	
Storage Length (ft)	230		0	0		0	331		150	0		0
Storage Lanes	1		0	0		1	0		1	0		0
Taper Length (ft)	150			0			25			0		
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt						0.850			0.850			
Flt Protected	0.950						0.950					
Satd. Flow (prot)	1752	3505	0	0	3539	1599	1761	0	1545	0	0	0
Flt Permitted	0.272						0.950					
Satd. Flow (perm)	502	3505	0	0	3539	1599	1761	0	1545	0	0	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)						722			125			
Link Speed (mph)		40			40			40			40	
Link Distance (ft)		594			302			1058			450	
Travel Time (s)		10.1			5.1			18.0			7.7	
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Heavy Vehicles (%)	3%	3%	0%	0%	2%	1%	2%	0%	4%	0%	0%	0%
Adj. Flow (vph)	338	1033	0	0	747	1489	241	0	252	0	0	0
Shared Lane Traffic (%)												
Lane Group Flow (vph)	338	1033	0	0	747	1489	241	0	252	0	0	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(ft)		12			12			12			12	
Link Offset(ft)		0			0			0			0	
Crosswalk Width(ft)		16			16			16			16	
Two way Left Turn Lane												
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.01	1.01	1.01	1.00	1.00	1.00
Turning Speed (mph)	15		9	15		9	15		9	15		9
Number of Detectors	1	1			1	1	1		1			
Detector Template	Left	Thru			Thru	Right	Left		Right			
Leading Detector (ft)	30	30			30	30	30		30			
Trailing Detector (ft)	0	0			0	0	0		0			
Detector 1 Position(ft)	0	0			0	0	0		0			
Detector 1 Size(ft)	30	30			30	30	30		30			
Detector 1 Type	Cl+Ex	Cl+Ex			Cl+Ex	Cl+Ex	Cl+Ex		Cl+Ex			
Detector 1 Channel												
Detector 1 Extend (s)	0.0	0.0			0.0	0.0	0.0		0.0			
Detector 1 Queue (s)	0.0	0.0			0.0	0.0	0.0		0.0			
Detector 1 Delay (s)	0.0	0.0			0.0	0.0	0.0		0.0			
Turn Type	D.P+P	NA			NA	Free	Perm		Perm			
Protected Phases	1	6			2							
Permitted Phases	2					Free	7		7			
Detector Phase	1	6			2		7		7			
Switch Phase												
Minimum Initial (s)	5.0	10.0			10.0		8.0		8.0			

Attachment E-4 – Synchro Analysis
2045 AM

Lanes, Volumes, Timings
2: I-49 NB Ramp & Route 58

07/10/2020

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Minimum Split (s)	12.0	15.3			21.3		15.0		15.0			
Total Split (s)	25.0	62.0			37.0		28.0		28.0			
Total Split (%)	27.8%	68.9%			41.1%		31.1%		31.1%			
Maximum Green (s)	19.7	56.7			31.7		22.1		22.1			
Yellow Time (s)	3.6	3.6			3.6		3.9		3.9			
All-Red Time (s)	1.7	1.7			1.7		2.0		2.0			
Lost Time Adjust (s)	0.0	0.0			0.0		0.0		0.0			
Total Lost Time (s)	5.3	5.3			5.3		5.9		5.9			
Lead/Lag	Lag				Lead							
Lead-Lag Optimize?	Yes				Yes							
Vehicle Extension (s)	3.0	3.0			3.0		3.0		3.0			
Recall Mode	None	C-Max			C-Max		None		None			
Walk Time (s)		7.0			5.0							
Flash Dont Walk (s)		12.0			11.0							
Pedestrian Calls (#/hr)		0			0							
Act Effct Green (s)	56.4	61.7			36.7	90.0	17.1		17.1			
Actuated g/C Ratio	0.63	0.69			0.41	1.00	0.19		0.19			
v/c Ratio	0.57	0.43			0.52	0.93	0.72		0.64			
Control Delay	21.0	6.7			8.2	21.1	46.1		23.6			
Queue Delay	0.0	0.0			0.8	0.0	0.0		0.0			
Total Delay	21.0	6.8			9.0	21.1	46.1		23.7			
LOS	C	A			A	C	D		C			
Approach Delay		10.3			17.1			34.6				
Approach LOS		B			B			C				

Intersection Summary

Area Type: Other

Cycle Length: 90

Actuated Cycle Length: 90

Offset: 88 (98%), Referenced to phase 2:EBWB and 6:EBT, Start of 1st Green

Natural Cycle: 50

Control Type: Actuated-Coordinated

Maximum v/c Ratio: 0.93

Intersection Signal Delay: 16.9

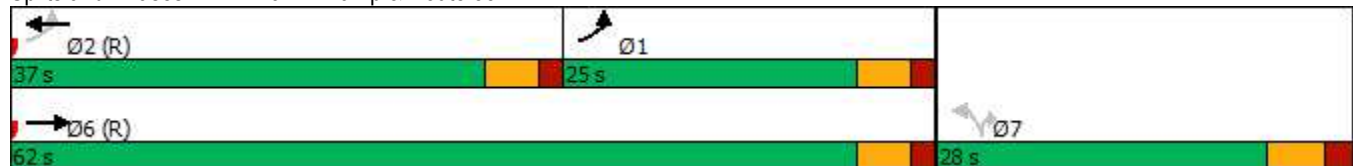
Intersection LOS: B

Intersection Capacity Utilization 64.9%

ICU Level of Service C

Analysis Period (min) 15

Splits and Phases: 2: I-49 NB Ramp & Route 58



Attachment E-4 – Synchro Analysis
2045 AM

Lanes, Volumes, Timings
3: I-49 SB Ramp & Route 58

07/10/2020

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	816	139	93	866	0	0	0	0	514	0	201
Future Volume (vph)	0	816	139	93	866	0	0	0	0	514	0	201
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		1%			0%			0%			2%	
Storage Length (ft)	0		0	140		0	0		0	0		350
Storage Lanes	0		0	1		0	0		0	2		1
Taper Length (ft)	0			150			0			0		
Lane Util. Factor	1.00	0.95	0.95	1.00	0.95	1.00	1.00	1.00	1.00	0.97	1.00	1.00
Frt		0.978										0.850
Flt Protected				0.950						0.950		
Satd. Flow (prot)	0	3401	0	1752	3539	0	0	0	0	3366	0	1552
Flt Permitted				0.207						0.950		
Satd. Flow (perm)	0	3401	0	382	3539	0	0	0	0	3366	0	1552
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		29										153
Link Speed (mph)		40			40			40			40	
Link Distance (ft)		315			594			338			1067	
Travel Time (s)		5.4			10.1			5.8			18.2	
Peak Hour Factor	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Heavy Vehicles (%)	0%	3%	5%	3%	2%	0%	0%	0%	0%	3%	0%	3%
Adj. Flow (vph)	0	850	145	97	902	0	0	0	0	535	0	209
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	995	0	97	902	0	0	0	0	535	0	209
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(ft)		12			12			24			24	
Link Offset(ft)		0			0			0			0	
Crosswalk Width(ft)		16			16			16			16	
Two way Left Turn Lane												
Headway Factor	1.01	1.01	1.01	1.00	1.00	1.00	1.00	1.00	1.00	1.01	1.01	1.01
Turning Speed (mph)	15		9	15		9	15		9	15		9
Number of Detectors		1		1	1					1		1
Detector Template		Thru		Left	Thru					Left		Right
Leading Detector (ft)		30		30	30					30		30
Trailing Detector (ft)		0		0	0					0		0
Detector 1 Position(ft)		0		0	0					0		0
Detector 1 Size(ft)		30		30	30					30		30
Detector 1 Type		Cl+Ex		Cl+Ex	Cl+Ex					Cl+Ex		Cl+Ex
Detector 1 Channel												
Detector 1 Extend (s)		0.0		0.0	0.0					0.0		0.0
Detector 1 Queue (s)		0.0		0.0	0.0					0.0		0.0
Detector 1 Delay (s)		0.0		0.0	0.0					0.0		0.0
Turn Type		NA		D,P+P	NA					Prot		Prot
Protected Phases		6		5	2					3		3
Permitted Phases				6								
Detector Phase		6		5	2					3		3
Switch Phase												
Minimum Initial (s)		10.0		6.0	10.0					8.0		8.0

Attachment E-4 – Synchro Analysis
2045 AM

Lanes, Volumes, Timings
3: I-49 SB Ramp & Route 58

07/10/2020

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Minimum Split (s)		21.6		12.0	21.6					15.0		15.0
Total Split (s)		48.0		12.0	60.0					30.0		30.0
Total Split (%)		53.3%		13.3%	66.7%					33.3%		33.3%
Maximum Green (s)		42.4		6.4	54.4					24.1		24.1
Yellow Time (s)		3.6		3.6	3.6					3.9		3.9
All-Red Time (s)		2.0		2.0	2.0					2.0		2.0
Lost Time Adjust (s)		0.0		0.0	0.0					0.0		0.0
Total Lost Time (s)		5.6		5.6	5.6					5.9		5.9
Lead/Lag	Lead			Lag								
Lead-Lag Optimize?	Yes			Yes								
Vehicle Extension (s)		5.0		5.0	3.0					6.0		6.0
Recall Mode	C-Max			None			C-Max			None		
Walk Time (s)		7.0			7.0							
Flash Dont Walk (s)		21.0			10.0							
Pedestrian Calls (#/hr)		0			0							
Act Effect Green (s)		46.5		51.6	56.1					22.4		22.4
Actuated g/C Ratio		0.52		0.57	0.62					0.25		0.25
v/c Ratio		0.56		0.31	0.41					0.64		0.42
Control Delay		10.5		5.8	3.2					33.8		11.2
Queue Delay		0.2		0.0	0.0					0.0		0.0
Total Delay		10.7		5.8	3.2					33.8		11.2
LOS		B		A	A					C		B
Approach Delay		10.7			3.4						27.4	
Approach LOS		B			A						C	

Intersection Summary

Area Type: Other

Cycle Length: 90

Actuated Cycle Length: 90

Offset: 86 (96%), Referenced to phase 2:WBT and 6:EBWB, Start of 1st Green

Natural Cycle: 60

Control Type: Actuated-Coordinated

Maximum v/c Ratio: 0.64

Intersection Signal Delay: 12.6

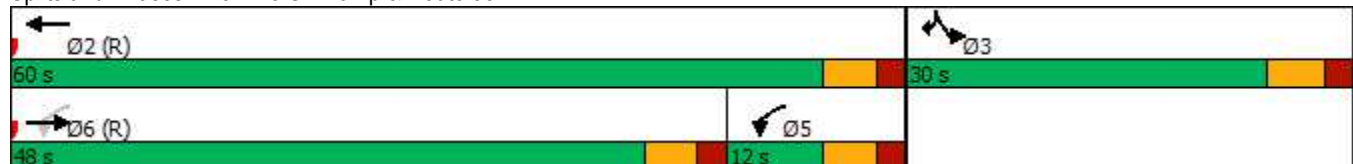
Intersection LOS: B

Intersection Capacity Utilization 64.9%

ICU Level of Service C

Analysis Period (min) 15

Splits and Phases: 3: I-49 SB Ramp & Route 58



Attachment E-4 – Synchro Analysis
2045 AM

Lanes, Volumes, Timings
4: Peculiar Dr & Route 58

07/10/2020

						
Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↑↑		↵	↑↑	↵	
Traffic Volume (vph)	687	1	60	1007	61	268
Future Volume (vph)	687	1	60	1007	61	268
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Grade (%)	2%			-1%	2%	
Storage Length (ft)		0	140		307	60
Storage Lanes		0	1		0	0
Taper Length (ft)			25		25	
Lane Util. Factor	0.95	0.95	1.00	0.95	1.00	1.00
Frt					0.890	
Flt Protected			0.950		0.991	
Satd. Flow (prot)	3470	0	1744	3557	1550	0
Flt Permitted			0.323		0.991	
Satd. Flow (perm)	3470	0	593	3557	1550	0
Right Turn on Red		Yes				Yes
Satd. Flow (RTOR)					247	
Link Speed (mph)	40			40	45	
Link Distance (ft)	881			315	346	
Travel Time (s)	15.0			5.4	5.2	
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89
Heavy Vehicles (%)	3%	0%	4%	2%	3%	8%
Adj. Flow (vph)	772	1	67	1131	69	301
Shared Lane Traffic (%)						
Lane Group Flow (vph)	773	0	67	1131	370	0
Enter Blocked Intersection	No	No	No	No	No	No
Lane Alignment	Left	Right	Left	Left	Left	Right
Median Width(ft)	12			12	12	
Link Offset(ft)	0			0	0	
Crosswalk Width(ft)	16			16	16	
Two way Left Turn Lane						
Headway Factor	1.01	1.01	0.99	0.99	1.01	1.01
Turning Speed (mph)		9	15		15	9
Number of Detectors	1		1	1	1	
Detector Template	Thru		Left	Thru	Left	
Leading Detector (ft)	30		30	30	30	
Trailing Detector (ft)	0		0	0	0	
Detector 1 Position(ft)	0		0	0	0	
Detector 1 Size(ft)	30		30	30	30	
Detector 1 Type	Cl+Ex		Cl+Ex	Cl+Ex	Cl+Ex	
Detector 1 Channel						
Detector 1 Extend (s)	0.0		0.0	0.0	0.0	
Detector 1 Queue (s)	0.0		0.0	0.0	0.0	
Detector 1 Delay (s)	0.0		0.0	0.0	0.0	
Turn Type	NA		D.P+P	NA	Prot	
Protected Phases	6		5	2	7	
Permitted Phases			6			
Detector Phase	6		5	2	7	
Switch Phase						
Minimum Initial (s)	10.0		6.0	10.0	8.0	

Attachment E-4 – Synchro Analysis
2045 AM

Lanes, Volumes, Timings
4: Peculiar Dr & Route 58

07/10/2020

	→	↘	↙	←	↖	↗
Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Minimum Split (s)	21.1		11.1	21.1	15.0	
Total Split (s)	42.0		12.0	54.0	36.0	
Total Split (%)	46.7%		13.3%	60.0%	40.0%	
Maximum Green (s)	36.9		6.9	48.9	30.5	
Yellow Time (s)	3.6		3.6	3.6	3.6	
All-Red Time (s)	1.5		1.5	1.5	1.9	
Lost Time Adjust (s)	0.0		0.0	0.0	0.0	
Total Lost Time (s)	5.1		5.1	5.1	5.5	
Lead/Lag	Lead		Lag			
Lead-Lag Optimize?	Yes		Yes			
Vehicle Extension (s)	3.0		3.0	3.0	3.0	
Recall Mode	C-Max		None	C-Max	None	
Walk Time (s)	7.0					
Flash Dont Walk (s)	11.0					
Pedestrian Calls (#/hr)	0					
Act Effect Green (s)	55.0		60.5	64.6	14.8	
Actuated g/C Ratio	0.61		0.67	0.72	0.16	
v/c Ratio	0.36		0.14	0.44	0.80	
Control Delay	11.2		2.8	2.2	25.2	
Queue Delay	0.0		0.0	0.1	0.0	
Total Delay	11.2		2.8	2.3	25.2	
LOS	B		A	A	C	
Approach Delay	11.2			2.3	25.2	
Approach LOS	B			A	C	

Intersection Summary

Area Type: Other

Cycle Length: 90

Actuated Cycle Length: 90

Offset: 2 (2%), Referenced to phase 2:WBT and 6:EBWB, Start of 1st Green

Natural Cycle: 55

Control Type: Actuated-Coordinated

Maximum v/c Ratio: 0.80

Intersection Signal Delay: 8.9

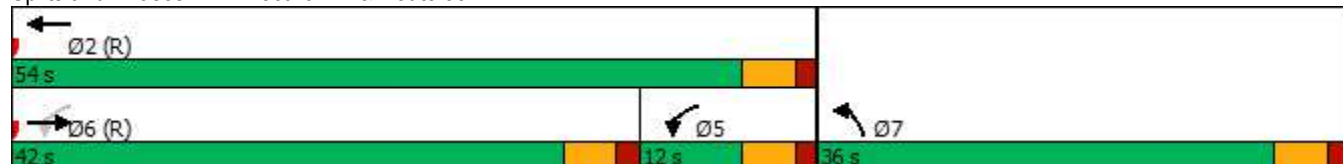
Intersection LOS: A

Intersection Capacity Utilization 57.0%

ICU Level of Service B

Analysis Period (min) 15

Splits and Phases: 4: Peculiar Dr & Route 58



Attachment E-4 – Synchro Analysis
2045 AM

Lanes, Volumes, Timings

30: I-49 SB Ramp & N. Cass Parkway

07/10/2020

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑↑↑	↑	↑	↑↑					↑↑		↑
Traffic Volume (vph)	0	167	49	242	228	0	0	0	0	81	0	26
Future Volume (vph)	0	167	49	242	228	0	0	0	0	81	0	26
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	60		290	0		0	0		0	380		380
Storage Lanes	1		1	1		0	0		0	1		1
Taper Length (ft)	25			0			0			25		
Lane Util. Factor	1.00	0.91	1.00	1.00	0.95	1.00	1.00	1.00	1.00	0.97	1.00	1.00
Frt			0.850									0.850
Flt Protected				0.950						0.950		
Satd. Flow (prot)	0	5085	1583	1770	3539	0	0	0	0	3433	0	1583
Flt Permitted				0.489						0.950		
Satd. Flow (perm)	0	5085	1583	911	3539	0	0	0	0	3433	0	1583
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)			179									192
Link Speed (mph)		45			45			40			40	
Link Distance (ft)		607			634			565			826	
Travel Time (s)		9.2			9.6			9.6			14.1	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	182	53	263	248	0	0	0	0	88	0	28
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	182	53	263	248	0	0	0	0	88	0	28
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(ft)		12			12			24			24	
Link Offset(ft)		0			0			0			0	
Crosswalk Width(ft)		16			16			16			16	
Two way Left Turn Lane												
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Turning Speed (mph)	15		9	15		9	15		9	15		9
Number of Detectors		2	1	1	2					1		1
Detector Template		Thru	Right	Left	Thru					Left		Right
Leading Detector (ft)		100	20	20	100					20		20
Trailing Detector (ft)		0	0	0	0					0		0
Detector 1 Position(ft)		0	0	0	0					0		0
Detector 1 Size(ft)		6	20	20	6					20		20
Detector 1 Type		Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex					Cl+Ex		Cl+Ex
Detector 1 Channel												
Detector 1 Extend (s)		0.0	0.0	0.0	0.0					0.0		0.0
Detector 1 Queue (s)		0.0	0.0	0.0	0.0					0.0		0.0
Detector 1 Delay (s)		0.0	0.0	0.0	0.0					0.0		0.0
Detector 2 Position(ft)		94			94							
Detector 2 Size(ft)		6			6							
Detector 2 Type		Cl+Ex			Cl+Ex							
Detector 2 Channel												
Detector 2 Extend (s)		0.0			0.0							
Turn Type		NA	Perm	pm+pt	NA					Prot		Perm
Protected Phases		4		3	8					5		
Permitted Phases			4	8								5

Attachment E-4 – Synchro Analysis
2045 AM

Lanes, Volumes, Timings

30: I-49 SB Ramp & N. Cass Parkway

07/10/2020

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Detector Phase		4	4	3	8					5		5
Switch Phase												
Minimum Initial (s)		10.0	10.0	7.0	10.0					7.0		7.0
Minimum Split (s)		21.6	21.6	12.5	21.2					12.7		12.7
Total Split (s)		21.6	21.6	15.0	36.6					13.4		13.4
Total Split (%)		43.2%	43.2%	30.0%	73.2%					26.8%		26.8%
Maximum Green (s)		15.3	15.3	9.5	31.4					7.7		7.7
Yellow Time (s)		4.8	4.8	4.1	4.1					4.0		4.0
All-Red Time (s)		1.5	1.5	1.4	1.1					1.7		1.7
Lost Time Adjust (s)		0.0	0.0	0.0	0.0					0.0		0.0
Total Lost Time (s)		6.3	6.3	5.5	5.2					5.7		5.7
Lead/Lag		Lag	Lag	Lead								
Lead-Lag Optimize?		Yes	Yes	Yes								
Vehicle Extension (s)		3.0	3.0	3.0	3.0					3.0		3.0
Recall Mode		Min	Min	None	Min					None		None
Act Effect Green (s)		17.6	17.6	19.4	15.9					25.3		25.3
Actuated g/C Ratio		0.35	0.35	0.39	0.32					0.51		0.51
v/c Ratio		0.10	0.08	0.51	0.22					0.05		0.03
Control Delay		14.9	0.2	10.5	1.1					13.1		0.1
Queue Delay		0.0	0.0	0.0	0.0					0.0		0.0
Total Delay		14.9	0.2	10.5	1.1					13.1		0.1
LOS		B	A	B	A					B		A
Approach Delay		11.6			5.9						10.0	
Approach LOS		B			A						A	

Intersection Summary

Area Type: Other

Cycle Length: 50

Actuated Cycle Length: 50

Offset: 25 (50%), Referenced to phase 2: and 6:, Start of Green

Natural Cycle: 50

Control Type: Actuated-Coordinated

Maximum v/c Ratio: 0.51

Intersection Signal Delay: 8.0

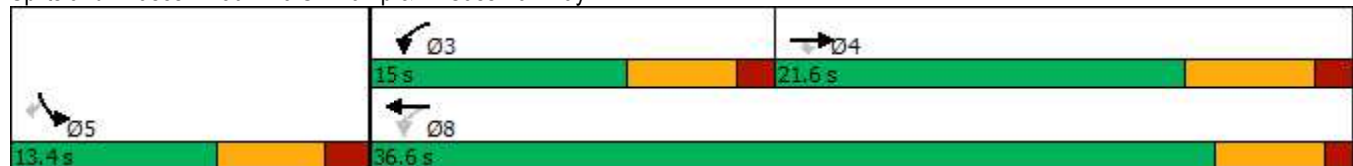
Intersection LOS: A

Intersection Capacity Utilization 42.2%

ICU Level of Service A

Analysis Period (min) 15

Splits and Phases: 30: I-49 SB Ramp & N. Cass Parkway



Attachment E-4 – Synchro Analysis
2045 AM

Lanes, Volumes, Timings

33: I-49 NB Ramp & N. Cass Parkway

07/10/2020

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	122	126	0	0	341	450	129	0	189	0	0	0
Future Volume (vph)	122	126	0	0	341	450	129	0	189	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0		0	60		320	285		285	0		0
Storage Lanes	1		0	1		1	0		1	0		0
Taper Length (ft)	0			25			25			0		
Lane Util. Factor	1.00	0.95	1.00	1.00	0.91	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt						0.850			0.850			
Flt Protected	0.950						0.950					
Satd. Flow (prot)	1770	3539	0	0	5085	1583	1770	0	1583	0	0	0
Flt Permitted	0.301						0.950					
Satd. Flow (perm)	561	3539	0	0	5085	1583	1770	0	1583	0	0	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)						489			205			
Link Speed (mph)		45			45			40			40	
Link Distance (ft)		634			604			748			707	
Travel Time (s)		9.6			9.2			12.8			12.1	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	133	137	0	0	371	489	140	0	205	0	0	0
Shared Lane Traffic (%)												
Lane Group Flow (vph)	133	137	0	0	371	489	140	0	205	0	0	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(ft)		12			12			12			12	
Link Offset(ft)		0			0			0			0	
Crosswalk Width(ft)		16			0			16			16	
Two way Left Turn Lane												
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Turning Speed (mph)	15		9	15		9	15		9	15		9
Number of Detectors	1	2			2	1	1		1			
Detector Template	Left	Thru			Thru	Right	Left		Right			
Leading Detector (ft)	20	100			100	20	20		20			
Trailing Detector (ft)	0	0			0	0	0		0			
Detector 1 Position(ft)	0	0			0	0	0		0			
Detector 1 Size(ft)	20	6			6	20	20		20			
Detector 1 Type	Cl+Ex	Cl+Ex			Cl+Ex	Cl+Ex	Cl+Ex		Cl+Ex			
Detector 1 Channel												
Detector 1 Extend (s)	0.0	0.0			0.0	0.0	0.0		0.0			
Detector 1 Queue (s)	0.0	0.0			0.0	0.0	0.0		0.0			
Detector 1 Delay (s)	0.0	0.0			0.0	0.0	0.0		0.0			
Detector 2 Position(ft)		94			94							
Detector 2 Size(ft)		6			6							
Detector 2 Type		Cl+Ex			Cl+Ex							
Detector 2 Channel												
Detector 2 Extend (s)		0.0			0.0							
Turn Type	pm+pt	NA			NA	Free	Prot		Perm			
Protected Phases	3	8			4		5					
Permitted Phases	8					Free			5			

Scenario 1 5:00 pm 10/08/2019 Baseline

Synchro 11 Report
Page 11

Attachment E-4 – Synchro Analysis
2045 AM

Lanes, Volumes, Timings

33: I-49 NB Ramp & N. Cass Parkway

07/10/2020

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Detector Phase	3	8			4		5		5			
Switch Phase												
Minimum Initial (s)	7.0	10.0			10.0		7.0		7.0			
Minimum Split (s)	13.1	20.0			20.0		12.4		12.4			
Total Split (s)	13.1	33.1			20.0		16.9		16.9			
Total Split (%)	26.2%	66.2%			40.0%		33.8%		33.8%			
Maximum Green (s)	7.0	27.6			14.6		11.5		11.5			
Yellow Time (s)	4.5	4.5			4.0		4.0		4.0			
All-Red Time (s)	1.6	1.0			1.4		1.4		1.4			
Lost Time Adjust (s)	0.0	0.0			0.0		0.0		0.0			
Total Lost Time (s)	6.1	5.5			5.4		5.4		5.4			
Lead/Lag	Lead				Lag							
Lead-Lag Optimize?	Yes				Yes							
Vehicle Extension (s)	3.0	3.0			3.0		3.0		3.0			
Recall Mode	None	Min			Min		None		None			
Act Effct Green (s)	20.1	19.2			8.4	50.0	21.0		21.0			
Actuated g/C Ratio	0.40	0.38			0.17	1.00	0.42		0.42			
v/c Ratio	0.33	0.10			0.44	0.31	0.19		0.26			
Control Delay	5.8	2.7			18.6	0.5	14.3		3.8			
Queue Delay	0.0	0.0			0.0	0.0	0.0		0.0			
Total Delay	5.8	2.7			18.6	0.5	14.3		3.8			
LOS	A	A			B	A	B		A			
Approach Delay		4.2			8.3			8.1				
Approach LOS		A			A			A				

Intersection Summary

Area Type: Other

Cycle Length: 50

Actuated Cycle Length: 50

Offset: 0 (0%), Referenced to phase 2: and 6:, Start of Green

Natural Cycle: 50

Control Type: Actuated-Coordinated

Maximum v/c Ratio: 0.44

Intersection Signal Delay: 7.5

Intersection LOS: A

Intersection Capacity Utilization 42.2%

ICU Level of Service A

Analysis Period (min) 15

Splits and Phases: 33: I-49 NB Ramp & N. Cass Parkway



Attachment E-4 – Synchro Analysis
2045 AM

Lanes, Volumes, Timings

65: I-49 NB Ramp & 163rd St./163rd St

07/10/2020

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰↰	↰↰			↰↰↰	↰	↰		↰			
Traffic Volume (vph)	717	347	0	0	743	665	231	0	173	0	0	0
Future Volume (vph)	717	347	0	0	743	665	231	0	173	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0		0	255		520	0		135	0		0
Storage Lanes	2		0	1		1	1		1	0		0
Taper Length (ft)	0			100			0			0		
Lane Util. Factor	0.97	0.95	1.00	1.00	0.91	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt						0.850			0.850			
Flt Protected	0.950						0.950					
Satd. Flow (prot)	3433	3539	0	0	5085	1583	1770	0	1583	0	0	0
Flt Permitted	0.950						0.950					
Satd. Flow (perm)	3433	3539	0	0	5085	1583	1770	0	1583	0	0	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)						439			231			
Link Speed (mph)		35			35			40			40	
Link Distance (ft)		335			638			913			594	
Travel Time (s)		6.5			12.4			15.6			10.1	
Peak Hour Factor	0.76	0.84	0.92	0.92	0.71	0.91	0.75	0.92	0.75	0.92	0.92	0.92
Adj. Flow (vph)	943	413	0	0	1046	731	308	0	231	0	0	0
Shared Lane Traffic (%)												
Lane Group Flow (vph)	943	413	0	0	1046	731	308	0	231	0	0	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Right	Right	Right	Left	Left	Right	Left	Left	Right
Median Width(ft)		24			24			12			12	
Link Offset(ft)		0			0			0			0	
Crosswalk Width(ft)		16			16			16			16	
Two way Left Turn Lane												
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Turning Speed (mph)	15		9	15		9	15		9	15		9
Number of Detectors	1	1			1	1	1		1			
Detector Template	Left	Thru			Thru	Right	Left		Right			
Leading Detector (ft)	30	30			30	30	30		30			
Trailing Detector (ft)	0	0			0	0	0		0			
Detector 1 Position(ft)	0	0			0	0	0		0			
Detector 1 Size(ft)	30	30			30	30	30		30			
Detector 1 Type	Cl+Ex	Cl+Ex			Cl+Ex	Cl+Ex	Cl+Ex		Cl+Ex			
Detector 1 Channel												
Detector 1 Extend (s)	0.0	0.0			0.0	0.0	0.0		0.0			
Detector 1 Queue (s)	0.0	0.0			0.0	0.0	0.0		0.0			
Detector 1 Delay (s)	0.0	0.0			0.0	0.0	0.0		0.0			
Turn Type	Prot	NA			NA	Perm	Prot		Perm			
Protected Phases	1	1 2			2		3					
Permitted Phases						2			3			
Detector Phase	1	1 2			2	2	3		3			
Switch Phase												
Minimum Initial (s)	6.0				12.0	12.0	6.0		6.0			
Minimum Split (s)	11.8				17.8	17.8	12.8		12.8			
Total Split (s)	29.0				29.0	29.0	22.0		22.0			

Lanes, Volumes, Timings

65: I-49 NB Ramp & 163rd St./163rd St

07/10/2020

Lane Group	Ø5	Ø6	Ø7
Lane Configurations			
Traffic Volume (vph)			
Future Volume (vph)			
Ideal Flow (vphpl)			
Storage Length (ft)			
Storage Lanes			
Taper Length (ft)			
Lane Util. Factor			
Frt			
Flt Protected			
Satd. Flow (prot)			
Flt Permitted			
Satd. Flow (perm)			
Right Turn on Red			
Satd. Flow (RTOR)			
Link Speed (mph)			
Link Distance (ft)			
Travel Time (s)			
Peak Hour Factor			
Adj. Flow (vph)			
Shared Lane Traffic (%)			
Lane Group Flow (vph)			
Enter Blocked Intersection			
Lane Alignment			
Median Width(ft)			
Link Offset(ft)			
Crosswalk Width(ft)			
Two way Left Turn Lane			
Headway Factor			
Turning Speed (mph)			
Number of Detectors			
Detector Template			
Leading Detector (ft)			
Trailing Detector (ft)			
Detector 1 Position(ft)			
Detector 1 Size(ft)			
Detector 1 Type			
Detector 1 Channel			
Detector 1 Extend (s)			
Detector 1 Queue (s)			
Detector 1 Delay (s)			
Turn Type			
Protected Phases	5	6	7
Permitted Phases			
Detector Phase			
Switch Phase			
Minimum Initial (s)	10.0	12.0	6.0
Minimum Split (s)	15.7	17.7	12.8
Total Split (s)	20.0	38.0	22.0

Attachment E-4 – Synchro Analysis
2045 AM

Lanes, Volumes, Timings

65: I-49 NB Ramp & 163rd St./163rd St

07/10/2020

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Total Split (%)	36.3%				36.3%	36.3%	27.5%		27.5%			
Maximum Green (s)	23.2				23.2	23.2	15.2		15.2			
Yellow Time (s)	3.6				3.6	3.6	3.6		3.6			
All-Red Time (s)	2.2				2.2	2.2	3.2		3.2			
Lost Time Adjust (s)	0.0				0.0	0.0	0.0		0.0			
Total Lost Time (s)	5.8				5.8	5.8	6.8		6.8			
Lead/Lag	Lead				Lag	Lag						
Lead-Lag Optimize?	Yes				Yes	Yes						
Vehicle Extension (s)	4.0				4.0	4.0	4.0		4.0			
Recall Mode	None				Min	Min	None		None			
Act Effct Green (s)	23.2	52.2			23.2	23.2	15.2		15.2			
Actuated g/C Ratio	0.29	0.65			0.29	0.29	0.19		0.19			
v/c Ratio	0.95	0.18			0.71	0.95	0.92		0.47			
Control Delay	34.0	3.6			28.6	35.3	66.3		7.9			
Queue Delay	0.4	0.0			0.0	0.0	0.0		0.0			
Total Delay	34.4	3.6			28.6	35.3	66.3		7.9			
LOS	C	A			C	D	E		A			
Approach Delay	25.0				31.3			41.2				
Approach LOS	C				C			D				

Intersection Summary

Area Type: Other

Cycle Length: 80

Actuated Cycle Length: 80

Natural Cycle: 80

Control Type: Actuated-Uncoordinated

Maximum v/c Ratio: 0.95

Intersection Signal Delay: 30.4

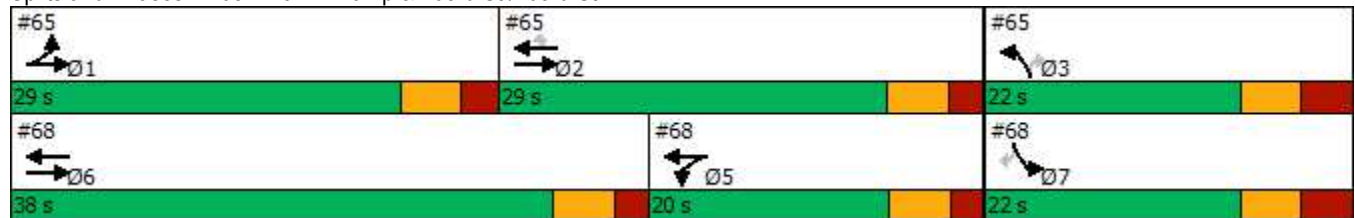
Intersection LOS: C

Intersection Capacity Utilization 89.8%

ICU Level of Service E

Analysis Period (min) 15

Splits and Phases: 65: I-49 NB Ramp & 163rd St./163rd St



Lanes, Volumes, Timings

65: I-49 NB Ramp & 163rd St./163rd St

07/10/2020

Lane Group	Ø5	Ø6	Ø7
Total Split (%)	25%	48%	28%
Maximum Green (s)	14.3	32.3	15.2
Yellow Time (s)	3.6	3.6	3.6
All-Red Time (s)	2.1	2.1	3.2
Lost Time Adjust (s)			
Total Lost Time (s)			
Lead/Lag	Lag	Lead	
Lead-Lag Optimize?	Yes	Yes	
Vehicle Extension (s)	4.0	4.0	4.0
Recall Mode	None	Min	None
Act Effect Green (s)			
Actuated g/C Ratio			
v/c Ratio			
Control Delay			
Queue Delay			
Total Delay			
LOS			
Approach Delay			
Approach LOS			
Intersection Summary			

Attachment E-4 – Synchro Analysis
2045 AM

Lanes, Volumes, Timings

68: I-49 SB Ramp & 163rd St/163rd St.

07/10/2020

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	741	36	94	880	0	0	0	0	323	0	345
Future Volume (vph)	0	741	36	94	880	0	0	0	0	323	0	345
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	390		0	0		0	0			285		340
Storage Lanes	2		0	1		0	0			1		1
Taper Length (ft)	110			0			0			120		
Lane Util. Factor	1.00	0.86	0.86	1.00	0.95	1.00	1.00	1.00	1.00	0.97	1.00	1.00
Frt		0.993										0.850
Flt Protected				0.950						0.950		
Satd. Flow (prot)	0	6363	0	1770	3539	0	0	0	0	3433	0	1583
Flt Permitted				0.950						0.950		
Satd. Flow (perm)	0	6363	0	1770	3539	0	0	0	0	3433	0	1583
Right Turn on Red			Yes			Yes				Yes		Yes
Satd. Flow (RTOR)		14										195
Link Speed (mph)		35			35			40			40	
Link Distance (ft)		628			335			662			1278	
Travel Time (s)		12.2			6.5			11.3			21.8	
Peak Hour Factor	0.92	0.79	0.78	0.60	0.78	0.92	0.92	0.92	0.92	0.91	0.92	0.89
Adj. Flow (vph)	0	938	46	157	1128	0	0	0	0	355	0	388
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	984	0	157	1128	0	0	0	0	355	0	388
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Right	Left	Right
Median Width(ft)		20			20			24			24	
Link Offset(ft)		0			0			0			0	
Crosswalk Width(ft)		16			16			16			16	
Two way Left Turn Lane												
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Turning Speed (mph)	15		9	15		9	15			9	15	9
Number of Detectors		1		1	1					1		1
Detector Template		Thru		Left	Thru					Left		Right
Leading Detector (ft)		30		30	30					30		30
Trailing Detector (ft)		0		0	0					0		0
Detector 1 Position(ft)		0		0	0					0		0
Detector 1 Size(ft)		30		30	30					30		30
Detector 1 Type		Cl+Ex		Cl+Ex	Cl+Ex					Cl+Ex		Cl+Ex
Detector 1 Channel												
Detector 1 Extend (s)		0.0		0.0	0.0					0.0		0.0
Detector 1 Queue (s)		0.0		0.0	0.0					0.0		0.0
Detector 1 Delay (s)		0.0		0.0	0.0					0.0		0.0
Turn Type		NA		Prot	NA					Prot		Perm
Protected Phases		6		5	5 6					7		
Permitted Phases												7
Detector Phase		6		5	5 6					7		7
Switch Phase												
Minimum Initial (s)		12.0		10.0						6.0		6.0
Minimum Split (s)		17.7		15.7						12.8		12.8
Total Split (s)		38.0		20.0						22.0		22.0

Lanes, Volumes, Timings

68: I-49 SB Ramp & 163rd St/163rd St.

07/10/2020

Lane Group	Ø1	Ø2	Ø3
Lane Configurations			
Traffic Volume (vph)			
Future Volume (vph)			
Ideal Flow (vphpl)			
Storage Length (ft)			
Storage Lanes			
Taper Length (ft)			
Lane Util. Factor			
Frt			
Flt Protected			
Satd. Flow (prot)			
Flt Permitted			
Satd. Flow (perm)			
Right Turn on Red			
Satd. Flow (RTOR)			
Link Speed (mph)			
Link Distance (ft)			
Travel Time (s)			
Peak Hour Factor			
Adj. Flow (vph)			
Shared Lane Traffic (%)			
Lane Group Flow (vph)			
Enter Blocked Intersection			
Lane Alignment			
Median Width(ft)			
Link Offset(ft)			
Crosswalk Width(ft)			
Two way Left Turn Lane			
Headway Factor			
Turning Speed (mph)			
Number of Detectors			
Detector Template			
Leading Detector (ft)			
Trailing Detector (ft)			
Detector 1 Position(ft)			
Detector 1 Size(ft)			
Detector 1 Type			
Detector 1 Channel			
Detector 1 Extend (s)			
Detector 1 Queue (s)			
Detector 1 Delay (s)			
Turn Type			
Protected Phases	1	2	3
Permitted Phases			
Detector Phase			
Switch Phase			
Minimum Initial (s)	6.0	12.0	6.0
Minimum Split (s)	11.8	17.8	12.8
Total Split (s)	29.0	29.0	22.0

Attachment E-4 – Synchro Analysis
2045 AM

Lanes, Volumes, Timings

68: I-49 SB Ramp & 163rd St/163rd St.

07/10/2020

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Total Split (%)		47.5%		25.0%						27.5%		27.5%
Maximum Green (s)		32.3		14.3						15.2		15.2
Yellow Time (s)		3.6		3.6						3.6		3.6
All-Red Time (s)		2.1		2.1						3.2		3.2
Lost Time Adjust (s)		0.0		0.0						0.0		0.0
Total Lost Time (s)		5.7		5.7						6.8		6.8
Lead/Lag		Lead		Lag								
Lead-Lag Optimize?		Yes		Yes								
Vehicle Extension (s)		4.0		4.0						4.0		4.0
Recall Mode		Min		None						None		None
Act Effect Green (s)		30.7		15.9	52.3					15.2		15.2
Actuated g/C Ratio		0.38		0.20	0.65					0.19		0.19
v/c Ratio		0.40		0.45	0.49					0.54		0.85
Control Delay		18.0		20.2	9.2					32.9		34.4
Queue Delay		0.0		0.0	0.5					0.0		0.0
Total Delay		18.0		20.2	9.7					32.9		34.4
LOS		B		C	A					C		C
Approach Delay		18.0			11.0						33.7	
Approach LOS		B			B						C	

Intersection Summary

Area Type: Other

Cycle Length: 80

Actuated Cycle Length: 80

Natural Cycle: 80

Control Type: Actuated-Uncoordinated

Maximum v/c Ratio: 0.95

Intersection Signal Delay: 18.9

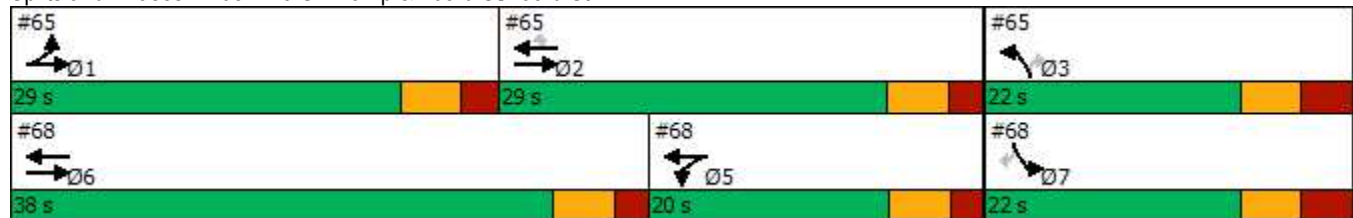
Intersection LOS: B

Intersection Capacity Utilization 89.8%

ICU Level of Service E

Analysis Period (min) 15

Splits and Phases: 68: I-49 SB Ramp & 163rd St/163rd St.



Lanes, Volumes, Timings

68: I-49 SB Ramp & 163rd St/163rd St.

07/10/2020

Lane Group	Ø1	Ø2	Ø3
Total Split (%)	36%	36%	28%
Maximum Green (s)	23.2	23.2	15.2
Yellow Time (s)	3.6	3.6	3.6
All-Red Time (s)	2.2	2.2	3.2
Lost Time Adjust (s)			
Total Lost Time (s)			
Lead/Lag	Lead	Lag	
Lead-Lag Optimize?	Yes	Yes	
Vehicle Extension (s)	4.0	4.0	4.0
Recall Mode	None	Min	None
Act Effect Green (s)			
Actuated g/C Ratio			
v/c Ratio			
Control Delay			
Queue Delay			
Total Delay			
LOS			
Approach Delay			
Approach LOS			
Intersection Summary			

**Attachment E-4 – Synchro Analysis
2045 PM**

**Lanes, Volumes, Timings
1: Harmon Drive & Route 58**

07/10/2020

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	46	1991	412	11	1572	60	218	31	33	79	32	120
Future Volume (vph)	46	1991	412	11	1572	60	218	31	33	79	32	120
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		0%			-1%			1%			3%	
Storage Length (ft)	90		0	205		135	200		40	130		55
Storage Lanes	1		0	1		0	1		0	1		0
Taper Length (ft)	25			25			25			25		
Lane Util. Factor	1.00	0.95	0.95	1.00	0.91	0.91	1.00	1.00	1.00	1.00	1.00	1.00
Frt		0.974			0.994			0.923			0.882	
Flt Protected	0.950			0.950			0.950			0.950		
Satd. Flow (prot)	1752	3487	0	1814	5128	0	1796	1745	0	1778	1638	0
Flt Permitted	0.094			0.048			0.000			0.000		
Satd. Flow (perm)	173	3487	0	92	5128	0	0	1745	0	0	1638	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		38			9			32			91	
Link Speed (mph)		40			40			45			45	
Link Distance (ft)		302			504			454			563	
Travel Time (s)		5.1			8.6			6.9			8.5	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Heavy Vehicles (%)	3%	1%	0%	0%	1%	2%	0%	0%	0%	0%	0%	1%
Adj. Flow (vph)	48	2096	434	12	1655	63	229	33	35	83	34	126
Shared Lane Traffic (%)												
Lane Group Flow (vph)	48	2530	0	12	1718	0	229	68	0	83	160	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(ft)		12			12			12			12	
Link Offset(ft)		0			0			0			0	
Crosswalk Width(ft)		16			16			16			16	
Two way Left Turn Lane												
Headway Factor	1.00	1.00	1.00	0.99	0.99	0.99	1.01	1.01	1.01	1.02	1.02	1.02
Turning Speed (mph)	15		9	15		9	15		9	15		9
Number of Detectors	1	1		1	1		1	1		1	1	
Detector Template	Left	Thru		Left	Thru		Left	Thru		Left	Thru	
Leading Detector (ft)	30	30		30	30		30	30		30	30	
Trailing Detector (ft)	0	0		0	0		0	0		0	0	
Detector 1 Position(ft)	0	0		0	0		0	0		0	0	
Detector 1 Size(ft)	30	30		30	30		30	30		30	30	
Detector 1 Type	Cl+Ex	Cl+Ex		Cl+Ex	Cl+Ex		Cl+Ex	Cl+Ex		Cl+Ex	Cl+Ex	
Detector 1 Channel												
Detector 1 Extend (s)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Detector 1 Queue (s)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Detector 1 Delay (s)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Turn Type	D.P+P	NA		D.P+P	NA		pm+pt	NA		pm+pt	NA	
Protected Phases	1	6		5	2		7	4		3	8	
Permitted Phases	2			6			4			8		
Detector Phase	1	6		5	2		7	4		3	8	
Switch Phase												
Minimum Initial (s)	5.0	10.0		5.0	10.0		5.0	5.0		4.0	5.0	

**Attachment E-4 – Synchro Analysis
2045 PM**

**Lanes, Volumes, Timings
1: Harmon Drive & Route 58**

07/10/2020

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Minimum Split (s)	11.0	15.6		11.0	15.6		11.2	12.0		11.0	12.0	
Total Split (s)	11.0	90.0		11.0	90.0		17.0	17.0		12.0	12.0	
Total Split (%)	8.5%	69.2%		8.5%	69.2%		13.1%	13.1%		9.2%	9.2%	
Maximum Green (s)	5.4	84.4		5.4	84.4		11.2	11.2		6.2	6.2	
Yellow Time (s)	3.6	3.6		3.6	3.6		4.2	4.2		4.2	4.2	
All-Red Time (s)	2.0	2.0		2.0	2.0		1.6	1.6		1.6	1.6	
Lost Time Adjust (s)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Total Lost Time (s)	5.6	5.6		5.6	5.6		5.8	5.8		5.8	5.8	
Lead/Lag	Lag	Lead		Lag	Lead		Lag	Lag		Lead	Lead	
Lead-Lag Optimize?	Yes	Yes		Yes	Yes		Yes	Yes		Yes	Yes	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	4.0		3.0	4.0	
Recall Mode	None	C-Max		None	C-Max		None	None		None	None	
Walk Time (s)		7.0			7.0							
Flash Dont Walk (s)		16.0			21.0							
Pedestrian Calls (#/hr)		0			0							
Act Effect Green (s)	89.8	88.8		92.0	84.4		12.2	10.3		11.8	7.4	
Actuated g/C Ratio	0.69	0.68		0.71	0.65		0.09	0.08		0.09	0.06	
v/c Ratio	0.26	1.06		0.09	0.52		1.36	0.41		0.52	0.90	
Control Delay	5.3	46.3		7.9	12.6		240.7	40.5		71.3	72.3	
Queue Delay	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Total Delay	5.3	46.3		7.9	12.6		240.7	40.5		71.3	72.3	
LOS	A	D		A	B		F	D		E	E	
Approach Delay		45.5			12.6			194.8			71.9	
Approach LOS		D			B			F			E	

Intersection Summary

Area Type: Other

Cycle Length: 130

Actuated Cycle Length: 130

Offset: 10 (8%), Referenced to phase 2:EBWB and 6:EBWB, Start of 1st Green

Natural Cycle: 150

Control Type: Actuated-Coordinated

Maximum v/c Ratio: 1.36

Intersection Signal Delay: 44.2

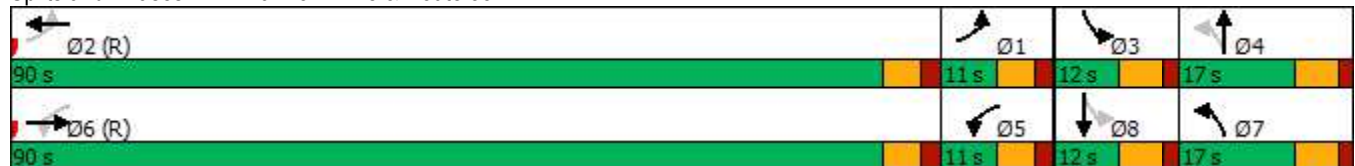
Intersection LOS: D

Intersection Capacity Utilization 103.7%

ICU Level of Service G

Analysis Period (min) 15

Splits and Phases: 1: Harmon Drive & Route 58



Attachment E-4 – Synchro Analysis
2045 PM

Lanes, Volumes, Timings
2: I-49 NB Ramp & Route 58

07/10/2020

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		 			 							
Traffic Volume (vph)	204	2289	0	0	1109	801	162	0	160	0	0	0
Future Volume (vph)	204	2289	0	0	1109	801	162	0	160	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		0%			0%			1%			0%	
Storage Length (ft)	230		0	0		0	331		150	0		0
Storage Lanes	1		0	0		1	0		1	0		0
Taper Length (ft)	150			0			25			0		
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt						0.850			0.850			
Flt Protected	0.950						0.950					
Satd. Flow (prot)	1805	3574	0	0	3574	1599	1744	0	1591	0	0	0
Flt Permitted	0.189						0.950					
Satd. Flow (perm)	359	3574	0	0	3574	1599	1744	0	1591	0	0	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)						418			64			
Link Speed (mph)		40			40			40			40	
Link Distance (ft)		594			302			1072			450	
Travel Time (s)		10.1			5.1			18.3			7.7	
Peak Hour Factor	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Heavy Vehicles (%)	0%	1%	0%	0%	1%	1%	3%	0%	1%	0%	0%	0%
Adj. Flow (vph)	213	2384	0	0	1155	834	169	0	167	0	0	0
Shared Lane Traffic (%)												
Lane Group Flow (vph)	213	2384	0	0	1155	834	169	0	167	0	0	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(ft)		12			12			12			12	
Link Offset(ft)		0			0			0			0	
Crosswalk Width(ft)		16			16			16			16	
Two way Left Turn Lane												
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.01	1.01	1.01	1.00	1.00	1.00
Turning Speed (mph)	15		9	15		9	15		9	15		9
Number of Detectors	1	1			1	1	1		1			
Detector Template	Left	Thru			Thru	Right	Left		Right			
Leading Detector (ft)	30	30			30	30	30		30			
Trailing Detector (ft)	0	0			0	0	0		0			
Detector 1 Position(ft)	0	0			0	0	0		0			
Detector 1 Size(ft)	30	30			30	30	30		30			
Detector 1 Type	Cl+Ex	Cl+Ex			Cl+Ex	Cl+Ex	Cl+Ex		Cl+Ex			
Detector 1 Channel												
Detector 1 Extend (s)	0.0	0.0			0.0	0.0	0.0		0.0			
Detector 1 Queue (s)	0.0	0.0			0.0	0.0	0.0		0.0			
Detector 1 Delay (s)	0.0	0.0			0.0	0.0	0.0		0.0			
Turn Type	D.P+P	NA			NA	Free	Perm		Perm			
Protected Phases	1	6			2							
Permitted Phases	2					Free	7		7			
Detector Phase	1	6			2		7		7			
Switch Phase												
Minimum Initial (s)	5.0	10.0			10.0		8.0		8.0			

Attachment E-4 – Synchro Analysis
2045 PM

Lanes, Volumes, Timings
2: I-49 NB Ramp & Route 58

07/10/2020

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Minimum Split (s)	12.0	15.3			21.3		15.0		15.0			
Total Split (s)	20.0	105.0			85.0		25.0		25.0			
Total Split (%)	15.4%	80.8%			65.4%		19.2%		19.2%			
Maximum Green (s)	14.7	99.7			79.7		19.1		19.1			
Yellow Time (s)	3.6	3.6			3.6		3.9		3.9			
All-Red Time (s)	1.7	1.7			1.7		2.0		2.0			
Lost Time Adjust (s)	0.0	0.0			0.0		0.0		0.0			
Total Lost Time (s)	5.3	5.3			5.3		5.9		5.9			
Lead/Lag	Lag				Lead							
Lead-Lag Optimize?	Yes				Yes							
Vehicle Extension (s)	3.0	3.0			3.0		3.0		3.0			
Recall Mode	None	C-Max			C-Max		None		None			
Walk Time (s)					5.0							
Flash Dont Walk (s)					11.0							
Pedestrian Calls (#/hr)					0							
Act Effct Green (s)	97.0	102.3			82.3	130.0	16.5		16.5			
Actuated g/C Ratio	0.75	0.79			0.63	1.00	0.13		0.13			
v/c Ratio	0.49	0.85			0.51	0.52	0.76		0.65			
Control Delay	3.5	2.9			6.5	3.1	76.6		44.6			
Queue Delay	0.0	4.3			0.2	0.0	0.0		6.8			
Total Delay	3.5	7.2			6.7	3.1	76.6		51.4			
LOS	A	A			A	A	E		D			
Approach Delay	6.9				5.2				64.1			
Approach LOS	A				A				E			

Intersection Summary

Area Type: Other

Cycle Length: 130

Actuated Cycle Length: 130

Offset: 6 (5%), Referenced to phase 2:EBWB and 6:EBT, Start of 1st Green

Natural Cycle: 75

Control Type: Actuated-Coordinated

Maximum v/c Ratio: 0.85

Intersection Signal Delay: 10.1

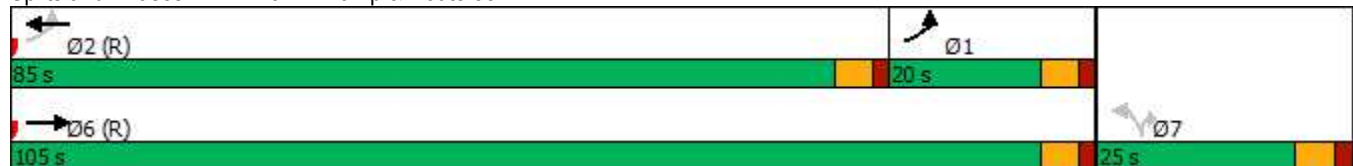
Intersection LOS: B

Intersection Capacity Utilization 124.9%

ICU Level of Service H

Analysis Period (min) 15

Splits and Phases: 2: I-49 NB Ramp & Route 58



Attachment E-4 – Synchro Analysis
2045 PM

Lanes, Volumes, Timings
3: I-49 SB Ramp & Route 58

07/10/2020

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	1243	320	163	1108	0	0	0	0	1250	0	295
Future Volume (vph)	0	1243	320	163	1108	0	0	0	0	1250	0	295
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		1%			0%			0%			2%	
Storage Length (ft)	0		0	140		0	0		0	0		350
Storage Lanes	0		0	1		0	0		0	2		1
Taper Length (ft)	0			150			0			0		
Lane Util. Factor	1.00	0.95	0.95	1.00	0.95	1.00	1.00	1.00	1.00	0.97	1.00	1.00
Frt		0.969										0.850
Flt Protected				0.950						0.950		
Satd. Flow (prot)	0	3466	0	1770	3574	0	0	0	0	3432	0	1567
Flt Permitted				0.068						0.950		
Satd. Flow (perm)	0	3466	0	127	3574	0	0	0	0	3432	0	1567
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		32										73
Link Speed (mph)		40			40			40			40	
Link Distance (ft)		315			594			338			1081	
Travel Time (s)		5.4			10.1			5.8			18.4	
Peak Hour Factor	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Heavy Vehicles (%)	0%	0%	2%	2%	1%	0%	0%	0%	0%	1%	0%	2%
Adj. Flow (vph)	0	1268	327	166	1131	0	0	0	0	1276	0	301
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	1595	0	166	1131	0	0	0	0	1276	0	301
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(ft)		12			12			24			24	
Link Offset(ft)		0			0			0			0	
Crosswalk Width(ft)		16			16			16			16	
Two way Left Turn Lane												
Headway Factor	1.01	1.01	1.01	1.00	1.00	1.00	1.00	1.00	1.00	1.01	1.01	1.01
Turning Speed (mph)	15		9	15		9	15		9	15		9
Number of Detectors		1		1	1					1		1
Detector Template		Thru		Left	Thru					Left		Right
Leading Detector (ft)		30		30	30					30		30
Trailing Detector (ft)		0		0	0					0		0
Detector 1 Position(ft)		0		0	0					0		0
Detector 1 Size(ft)		30		30	30					30		30
Detector 1 Type		Cl+Ex		Cl+Ex	Cl+Ex					Cl+Ex		Cl+Ex
Detector 1 Channel												
Detector 1 Extend (s)		0.0		0.0	0.0					0.0		0.0
Detector 1 Queue (s)		0.0		0.0	0.0					0.0		0.0
Detector 1 Delay (s)		0.0		0.0	0.0					0.0		0.0
Turn Type		NA		D,P+P	NA					Prot		Prot
Protected Phases		6		5	2					3		3
Permitted Phases				6								
Detector Phase		6		5	2					3		3
Switch Phase												
Minimum Initial (s)		10.0		6.0	10.0					8.0		8.0

Attachment E-4 – Synchro Analysis
2045 PM

Lanes, Volumes, Timings
3: I-49 SB Ramp & Route 58

07/10/2020

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Minimum Split (s)		21.6		12.0	21.6					15.0		15.0
Total Split (s)		64.0		14.0	78.0					52.0		52.0
Total Split (%)		49.2%		10.8%	60.0%					40.0%		40.0%
Maximum Green (s)		58.4		8.4	72.4					46.1		46.1
Yellow Time (s)		3.6		3.6	3.6					3.9		3.9
All-Red Time (s)		2.0		2.0	2.0					2.0		2.0
Lost Time Adjust (s)		0.0		0.0	0.0					0.0		0.0
Total Lost Time (s)		5.6		5.6	5.6					5.9		5.9
Lead/Lag		Lag		Lead								
Lead-Lag Optimize?		Yes		Yes								
Vehicle Extension (s)		5.0		5.0	3.0					6.0		6.0
Recall Mode		C-Max		None	C-Max					None		None
Walk Time (s)		7.0			7.0							
Flash Dont Walk (s)		21.0			10.0							
Pedestrian Calls (#/hr)		0			0							
Act Effect Green (s)		58.4		66.8	72.4					46.1		46.1
Actuated g/C Ratio		0.45		0.51	0.56					0.35		0.35
v/c Ratio		1.01		0.97	0.57					1.05		0.50
Control Delay		52.2		98.3	15.5					80.2		27.8
Queue Delay		14.4		0.0	0.2					0.0		0.0
Total Delay		66.6		98.3	15.7					80.2		27.8
LOS		E		F	B					F		C
Approach Delay		66.6			26.2						70.2	
Approach LOS		E			C						E	

Intersection Summary

Area Type: Other

Cycle Length: 130

Actuated Cycle Length: 130

Offset: 102 (78%), Referenced to phase 2:WBT and 6:EBWB, Start of 1st Green

Natural Cycle: 120

Control Type: Actuated-Coordinated

Maximum v/c Ratio: 1.05

Intersection Signal Delay: 56.2

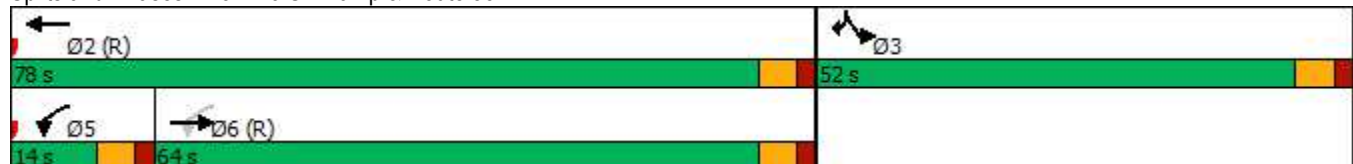
Intersection LOS: E

Intersection Capacity Utilization 124.9%

ICU Level of Service H

Analysis Period (min) 15

Splits and Phases: 3: I-49 SB Ramp & Route 58



Attachment E-4 – Synchro Analysis
2045 PM

Lanes, Volumes, Timings
4: Peculiar Dr & Route 58

07/10/2020

						
Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↑↑		↵	↑↑	↵	
Traffic Volume (vph)	1482	46	85	1318	32	81
Future Volume (vph)	1482	46	85	1318	32	81
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Grade (%)	2%			-1%	2%	
Storage Length (ft)		0	140		307	60
Storage Lanes		0	1		0	0
Taper Length (ft)			25		25	
Lane Util. Factor	0.95	0.95	1.00	0.95	1.00	1.00
Frt	0.996				0.904	
Flt Protected			0.950		0.986	
Satd. Flow (prot)	3525	0	1814	3592	1653	0
Flt Permitted			0.118		0.986	
Satd. Flow (perm)	3525	0	225	3592	1653	0
Right Turn on Red		Yes				Yes
Satd. Flow (RTOR)	5				79	
Link Speed (mph)	40			40	45	
Link Distance (ft)	881			315	346	
Travel Time (s)	15.0			5.4	5.2	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Heavy Vehicles (%)	1%	0%	0%	1%	0%	2%
Adj. Flow (vph)	1560	48	89	1387	34	85
Shared Lane Traffic (%)						
Lane Group Flow (vph)	1608	0	89	1387	119	0
Enter Blocked Intersection	No	No	No	No	No	No
Lane Alignment	Left	Right	Left	Left	Left	Right
Median Width(ft)	12			12	12	
Link Offset(ft)	0			0	0	
Crosswalk Width(ft)	16			16	16	
Two way Left Turn Lane						
Headway Factor	1.01	1.01	0.99	0.99	1.01	1.01
Turning Speed (mph)		9	15		15	9
Number of Detectors	1		1	1	1	
Detector Template	Thru		Left	Thru	Left	
Leading Detector (ft)	30		30	30	30	
Trailing Detector (ft)	0		0	0	0	
Detector 1 Position(ft)	0		0	0	0	
Detector 1 Size(ft)	30		30	30	30	
Detector 1 Type	Cl+Ex		Cl+Ex	Cl+Ex	Cl+Ex	
Detector 1 Channel						
Detector 1 Extend (s)	0.0		0.0	0.0	0.0	
Detector 1 Queue (s)	0.0		0.0	0.0	0.0	
Detector 1 Delay (s)	0.0		0.0	0.0	0.0	
Turn Type	NA		D.P+P	NA	Prot	
Protected Phases	6		5	2	7	
Permitted Phases			6			
Detector Phase	6		5	2	7	
Switch Phase						
Minimum Initial (s)	10.0		6.0	10.0	8.0	

Lanes, Volumes, Timings
4: Peculiar Dr & Route 58

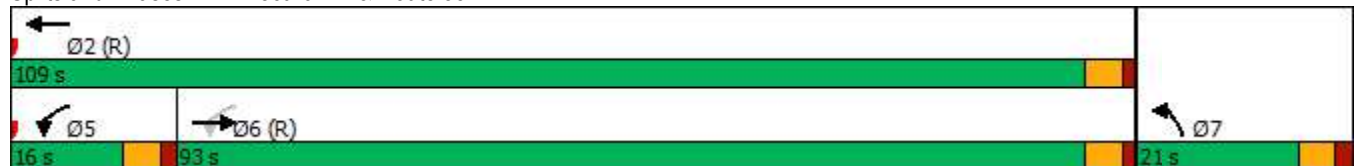
07/10/2020

	→	↘	↙	←	↖	↗
Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Minimum Split (s)	21.1		11.1	21.1	15.0	
Total Split (s)	93.0		16.0	109.0	21.0	
Total Split (%)	71.5%		12.3%	83.8%	16.2%	
Maximum Green (s)	87.9		10.9	103.9	15.5	
Yellow Time (s)	3.6		3.6	3.6	3.6	
All-Red Time (s)	1.5		1.5	1.5	1.9	
Lost Time Adjust (s)	0.0		0.0	0.0	0.0	
Total Lost Time (s)	5.1		5.1	5.1	5.5	
Lead/Lag	Lag		Lead			
Lead-Lag Optimize?	Yes		Yes			
Vehicle Extension (s)	3.0		3.0	3.0	3.0	
Recall Mode	C-Max		None	C-Max	None	
Walk Time (s)	7.0					
Flash Dont Walk (s)	11.0					
Pedestrian Calls (#/hr)	0					
Act Effect Green (s)	97.6		104.2	109.3	10.1	
Actuated g/C Ratio	0.75		0.80	0.84	0.08	
v/c Ratio	0.61		0.34	0.46	0.59	
Control Delay	9.0		5.3	1.2	34.4	
Queue Delay	0.6		0.0	0.1	0.9	
Total Delay	9.6		5.3	1.3	35.2	
LOS	A		A	A	D	
Approach Delay	9.6			1.5	35.2	
Approach LOS	A			A	D	

Intersection Summary

Area Type: Other
 Cycle Length: 130
 Actuated Cycle Length: 130
 Offset: 98 (75%), Referenced to phase 2:WBT and 6:EBWB, Start of 1st Green
 Natural Cycle: 60
 Control Type: Actuated-Coordinated
 Maximum v/c Ratio: 0.61
 Intersection Signal Delay: 6.8
 Intersection LOS: A
 Intersection Capacity Utilization 67.3%
 ICU Level of Service C
 Analysis Period (min) 15

Splits and Phases: 4: Peculiar Dr & Route 58



Attachment E-4 – Synchro Analysis
2045 PM

Lanes, Volumes, Timings

30: I-49 SB Ramp & N. Cass Parkway

07/10/2020

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑↑↑	↑	↑	↑↑					↑↑		↑
Traffic Volume (vph)	0	184	117	325	291	0	0	0	0	279	0	177
Future Volume (vph)	0	184	117	325	291	0	0	0	0	279	0	177
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	60		290	0		0	0		0	380		380
Storage Lanes	1		1	1		0	0		0	1		1
Taper Length (ft)	25			0			0			25		
Lane Util. Factor	1.00	0.91	1.00	1.00	0.95	1.00	1.00	1.00	1.00	0.97	1.00	1.00
Frt			0.850									0.850
Flt Protected				0.950						0.950		
Satd. Flow (prot)	0	5085	1583	1770	3539	0	0	0	0	3433	0	1583
Flt Permitted				0.448						0.950		
Satd. Flow (perm)	0	5085	1583	835	3539	0	0	0	0	3433	0	1583
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)			179									192
Link Speed (mph)		45			45			40			40	
Link Distance (ft)		607			634			565			826	
Travel Time (s)		9.2			9.6			9.6			14.1	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	200	127	353	316	0	0	0	0	303	0	192
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	200	127	353	316	0	0	0	0	303	0	192
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(ft)		12			12			24			24	
Link Offset(ft)		0			0			0			0	
Crosswalk Width(ft)		16			16			16			16	
Two way Left Turn Lane												
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Turning Speed (mph)	15		9	15		9	15		9	15		9
Number of Detectors		2	1	1	2					1		1
Detector Template		Thru	Right	Left	Thru					Left		Right
Leading Detector (ft)		100	20	20	100					20		20
Trailing Detector (ft)		0	0	0	0					0		0
Detector 1 Position(ft)		0	0	0	0					0		0
Detector 1 Size(ft)		6	20	20	6					20		20
Detector 1 Type		Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex					Cl+Ex		Cl+Ex
Detector 1 Channel												
Detector 1 Extend (s)		0.0	0.0	0.0	0.0					0.0		0.0
Detector 1 Queue (s)		0.0	0.0	0.0	0.0					0.0		0.0
Detector 1 Delay (s)		0.0	0.0	0.0	0.0					0.0		0.0
Detector 2 Position(ft)		94			94							
Detector 2 Size(ft)		6			6							
Detector 2 Type		Cl+Ex			Cl+Ex							
Detector 2 Channel												
Detector 2 Extend (s)		0.0			0.0							
Turn Type		NA	Perm	pm+pt	NA					Prot		Perm
Protected Phases		4		3	8					5		
Permitted Phases			4	8								5

Attachment E-4 – Synchro Analysis
2045 PM

Lanes, Volumes, Timings

30: I-49 SB Ramp & N. Cass Parkway

07/10/2020

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Detector Phase		4	4	3	8					5		5
Switch Phase												
Minimum Initial (s)		10.0	10.0	7.0	10.0					7.0		7.0
Minimum Split (s)		21.6	21.6	12.5	21.2					12.7		12.7
Total Split (s)		21.6	21.6	14.0	35.6					14.4		14.4
Total Split (%)		43.2%	43.2%	28.0%	71.2%					28.8%		28.8%
Maximum Green (s)		15.3	15.3	8.5	30.4					8.7		8.7
Yellow Time (s)		4.8	4.8	4.1	4.1					4.0		4.0
All-Red Time (s)		1.5	1.5	1.4	1.1					1.7		1.7
Lost Time Adjust (s)		0.0	0.0	0.0	0.0					0.0		0.0
Total Lost Time (s)		6.3	6.3	5.5	5.2					5.7		5.7
Lead/Lag		Lag	Lag	Lead								
Lead-Lag Optimize?		Yes	Yes	Yes								
Vehicle Extension (s)		3.0	3.0	3.0	3.0					3.0		3.0
Recall Mode		C-Min	C-Min	None	C-Min					None		None
Act Effect Green (s)		13.1	13.1	29.1	29.4					9.7		9.7
Actuated g/C Ratio		0.26	0.26	0.58	0.59					0.19		0.19
v/c Ratio		0.15	0.23	0.53	0.15					0.45		0.42
Control Delay		15.9	2.9	5.9	1.5					19.6		6.2
Queue Delay		0.0	0.0	0.0	0.0					0.0		0.0
Total Delay		15.9	2.9	5.9	1.5					19.6		6.2
LOS		B	A	A	A					B		A
Approach Delay		10.8			3.8						14.4	
Approach LOS		B			A						B	

Intersection Summary

Area Type: Other

Cycle Length: 50

Actuated Cycle Length: 50

Offset: 2.4 (5%), Referenced to phase 4:EBT and 8:WBTL, Start of Green

Natural Cycle: 50

Control Type: Actuated-Coordinated

Maximum v/c Ratio: 0.53

Intersection Signal Delay: 8.9

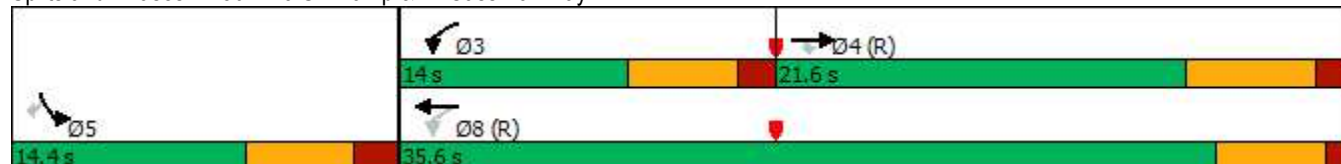
Intersection LOS: A

Intersection Capacity Utilization 48.4%

ICU Level of Service A

Analysis Period (min) 15

Splits and Phases: 30: I-49 SB Ramp & N. Cass Parkway



Attachment E-4 – Synchro Analysis
2045 PM

Lanes, Volumes, Timings

33: I-49 NB Ramp & N. Cass Parkway

07/10/2020

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		 			  							
Traffic Volume (vph)	112	351	0	0	502	482	114	0	261	0	0	0
Future Volume (vph)	112	351	0	0	502	482	114	0	261	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0		0	60		320	285		285	0		0
Storage Lanes	1		0	1		1	0		1	0		0
Taper Length (ft)	0			25			25			0		
Lane Util. Factor	1.00	0.95	1.00	1.00	0.91	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt						0.850			0.850			
Flt Protected	0.950						0.950					
Satd. Flow (prot)	1770	3539	0	0	5085	1583	1770	0	1583	0	0	0
Flt Permitted	0.328						0.950					
Satd. Flow (perm)	611	3539	0	0	5085	1583	1770	0	1583	0	0	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)						524			284			
Link Speed (mph)		45			45			40			40	
Link Distance (ft)		634			604			748			707	
Travel Time (s)		9.6			9.2			12.8			12.1	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	122	382	0	0	546	524	124	0	284	0	0	0
Shared Lane Traffic (%)												
Lane Group Flow (vph)	122	382	0	0	546	524	124	0	284	0	0	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(ft)		12			12			12			12	
Link Offset(ft)		0			0			0			0	
Crosswalk Width(ft)		16			0			16			16	
Two way Left Turn Lane												
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Turning Speed (mph)	15		9	15		9	15		9	15		9
Number of Detectors	1	2			2	1	1		1			
Detector Template	Left	Thru			Thru	Right	Left		Right			
Leading Detector (ft)	20	100			100	20	20		20			
Trailing Detector (ft)	0	0			0	0	0		0			
Detector 1 Position(ft)	0	0			0	0	0		0			
Detector 1 Size(ft)	20	6			6	20	20		20			
Detector 1 Type	Cl+Ex	Cl+Ex			Cl+Ex	Cl+Ex	Cl+Ex		Cl+Ex			
Detector 1 Channel												
Detector 1 Extend (s)	0.0	0.0			0.0	0.0	0.0		0.0			
Detector 1 Queue (s)	0.0	0.0			0.0	0.0	0.0		0.0			
Detector 1 Delay (s)	0.0	0.0			0.0	0.0	0.0		0.0			
Detector 2 Position(ft)		94			94							
Detector 2 Size(ft)		6			6							
Detector 2 Type		Cl+Ex			Cl+Ex							
Detector 2 Channel												
Detector 2 Extend (s)		0.0			0.0							
Turn Type	pm+pt	NA			NA	Free	Prot		Perm			
Protected Phases	3	8			4		5					
Permitted Phases	8					Free			5			

Attachment E-4 – Synchro Analysis
2045 PM

Lanes, Volumes, Timings

33: I-49 NB Ramp & N. Cass Parkway

07/10/2020

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Detector Phase	3	8			4		5		5			
Switch Phase												
Minimum Initial (s)	7.0	10.0			10.0		7.0		7.0			
Minimum Split (s)	13.1	20.0			20.0		12.4		12.4			
Total Split (s)	13.1	33.1			20.0		16.9		16.9			
Total Split (%)	26.2%	66.2%			40.0%		33.8%		33.8%			
Maximum Green (s)	7.0	27.6			14.6		11.5		11.5			
Yellow Time (s)	4.5	4.5			4.0		4.0		4.0			
All-Red Time (s)	1.6	1.0			1.4		1.4		1.4			
Lost Time Adjust (s)	0.0	0.0			0.0		0.0		0.0			
Total Lost Time (s)	6.1	5.5			5.4		5.4		5.4			
Lead/Lag	Lead				Lag							
Lead-Lag Optimize?	Yes				Yes							
Vehicle Extension (s)	3.0	3.0			3.0		3.0		3.0			
Recall Mode	None	C-Min			C-Min		None		None			
Act Effct Green (s)	29.5	30.1			19.6	50.0	9.0		9.0			
Actuated g/C Ratio	0.59	0.60			0.39	1.00	0.18		0.18			
v/c Ratio	0.23	0.18			0.27	0.33	0.39		0.55			
Control Delay	2.5	1.0			12.5	0.6	21.3		7.3			
Queue Delay	0.0	0.0			0.0	0.0	0.0		0.0			
Total Delay	2.5	1.0			12.5	0.6	21.3		7.3			
LOS	A	A			B	A	C		A			
Approach Delay		1.3			6.7		11.5					
Approach LOS		A			A		B					

Intersection Summary

Area Type: Other

Cycle Length: 50

Actuated Cycle Length: 50

Offset: 30 (60%), Referenced to phase 4:WBT and 8:EBTL, Start of Green

Natural Cycle: 50

Control Type: Actuated-Coordinated

Maximum v/c Ratio: 0.55

Intersection Signal Delay: 6.3

Intersection LOS: A

Intersection Capacity Utilization 48.4%

ICU Level of Service A

Analysis Period (min) 15

Splits and Phases: 33: I-49 NB Ramp & N. Cass Parkway



**Attachment E-4 – Synchro Analysis
2045 PM**

Lanes, Volumes, Timings
65: I-49 NB Ramp & 163rd St

07/10/2020

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	656	881	0	0	524	283	170	0	110	0	0	0
Future Volume (vph)	656	881	0	0	524	283	170	0	110	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0		0	255		520	0		135	0		0
Storage Lanes	2		0	1		1	1		1	0		0
Taper Length (ft)	0			100			0			0		
Lane Util. Factor	0.97	0.95	1.00	1.00	0.91	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt						0.850			0.850			
Flt Protected	0.950						0.950					
Satd. Flow (prot)	3433	3539	0	0	5085	1583	1770	0	1583	0	0	0
Flt Permitted	0.950						0.950					
Satd. Flow (perm)	3433	3539	0	0	5085	1583	1770	0	1583	0	0	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)						329			182			
Link Speed (mph)		35			35			40			40	
Link Distance (ft)		335			765			916			376	
Travel Time (s)		6.5			14.9			15.6			6.4	
Peak Hour Factor	0.90	0.93	0.92	0.92	0.90	0.86	0.83	0.92	0.82	0.92	0.92	0.92
Adj. Flow (vph)	729	947	0	0	582	329	205	0	134	0	0	0
Shared Lane Traffic (%)												
Lane Group Flow (vph)	729	947	0	0	582	329	205	0	134	0	0	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(ft)		24			24			12			12	
Link Offset(ft)		0			0			0			0	
Crosswalk Width(ft)		16			16			16			16	
Two way Left Turn Lane												
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Turning Speed (mph)	15		9	15		9	15		9	15		9
Number of Detectors	1	1			1	1	1		1			
Detector Template	Left	Thru			Thru	Right	Left		Right			
Leading Detector (ft)	30	30			30	30	30		30			
Trailing Detector (ft)	0	0			0	0	0		0			
Detector 1 Position(ft)	0	0			0	0	0		0			
Detector 1 Size(ft)	30	30			30	30	30		30			
Detector 1 Type	Cl+Ex	Cl+Ex			Cl+Ex	Cl+Ex	Cl+Ex		Cl+Ex			
Detector 1 Channel												
Detector 1 Extend (s)	0.0	0.0			0.0	0.0	0.0		0.0			
Detector 1 Queue (s)	0.0	0.0			0.0	0.0	0.0		0.0			
Detector 1 Delay (s)	0.0	0.0			0.0	0.0	0.0		0.0			
Turn Type	Prot	NA			NA	Perm	Prot		Perm			
Protected Phases	1 4	1 2 4			2		3					
Permitted Phases						2			3			
Detector Phase	1	1 2			2	2	3		3			
Switch Phase												
Minimum Initial (s)					12.0	12.0	6.0		6.0			
Minimum Split (s)					17.6	17.6	12.8		12.8			
Total Split (s)					24.5	24.5	25.4		25.4			

Lanes, Volumes, Timings
65: I-49 NB Ramp & 163rd St

07/10/2020

Lane Group	Ø1	Ø4	Ø5	Ø6	Ø7
Lane Configurations					
Traffic Volume (vph)					
Future Volume (vph)					
Ideal Flow (vphpl)					
Storage Length (ft)					
Storage Lanes					
Taper Length (ft)					
Lane Util. Factor					
Frt					
Flt Protected					
Satd. Flow (prot)					
Flt Permitted					
Satd. Flow (perm)					
Right Turn on Red					
Satd. Flow (RTOR)					
Link Speed (mph)					
Link Distance (ft)					
Travel Time (s)					
Peak Hour Factor					
Adj. Flow (vph)					
Shared Lane Traffic (%)					
Lane Group Flow (vph)					
Enter Blocked Intersection					
Lane Alignment					
Median Width(ft)					
Link Offset(ft)					
Crosswalk Width(ft)					
Two way Left Turn Lane					
Headway Factor					
Turning Speed (mph)					
Number of Detectors					
Detector Template					
Leading Detector (ft)					
Trailing Detector (ft)					
Detector 1 Position(ft)					
Detector 1 Size(ft)					
Detector 1 Type					
Detector 1 Channel					
Detector 1 Extend (s)					
Detector 1 Queue (s)					
Detector 1 Delay (s)					
Turn Type					
Protected Phases	1	4	5	6	7
Permitted Phases					
Detector Phase					
Switch Phase					
Minimum Initial (s)	6.0	4.0	10.0	12.0	6.0
Minimum Split (s)	11.5	16.0	15.6	17.5	12.8
Total Split (s)	18.1	22.0	16.5	26.1	47.4

Attachment E-4 – Synchro Analysis
2045 PM

Lanes, Volumes, Timings
65: I-49 NB Ramp & 163rd St

07/10/2020

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Total Split (%)					27.2%	27.2%	28.2%		28.2%			
Maximum Green (s)					18.9	18.9	18.6		18.6			
Yellow Time (s)					3.6	3.6	3.6		3.6			
All-Red Time (s)					2.0	2.0	3.2		3.2			
Lost Time Adjust (s)					0.0	0.0	0.0		0.0			
Total Lost Time (s)					5.6	5.6	6.8		6.8			
Lead/Lag					Lead	Lead	Lead		Lead			
Lead-Lag Optimize?					Yes	Yes	Yes		Yes			
Vehicle Extension (s)					4.0	4.0	4.0		4.0			
Recall Mode					Min	Min	None		None			
Act Effct Green (s)	32.2	62.0			18.6	18.6	15.7		15.7			
Actuated g/C Ratio	0.36	0.69			0.21	0.21	0.17		0.17			
v/c Ratio	0.59	0.39			0.55	0.56	0.66		0.31			
Control Delay	17.0	4.3			34.2	7.7	45.1		3.9			
Queue Delay	0.0	0.5			0.0	0.0	0.0		0.0			
Total Delay	17.0	4.7			34.2	7.7	45.1		3.9			
LOS	B	A			C	A	D		A			
Approach Delay		10.0			24.6			28.8				
Approach LOS		B			C			C				

Intersection Summary

Area Type: Other

Cycle Length: 90

Actuated Cycle Length: 90

Natural Cycle: 100

Control Type: Actuated-Uncoordinated

Maximum v/c Ratio: 1.04

Intersection Signal Delay: 16.8

Intersection LOS: B

Intersection Capacity Utilization 102.3%

ICU Level of Service G

Analysis Period (min) 15

Splits and Phases: 65: I-49 NB Ramp & 163rd St

#65 	#65 	#65 	#65 
24.5 s	18.1 s	25.4 s	22 s
#68 	#68 	#68 	
26.1 s	16.5 s	47.4 s	

Lanes, Volumes, Timings
65: I-49 NB Ramp & 163rd St

07/10/2020

Lane Group	Ø1	Ø4	Ø5	Ø6	Ø7
Total Split (%)	20%	24%	18%	29%	53%
Maximum Green (s)	12.6	16.5	10.9	20.6	40.6
Yellow Time (s)	3.6	3.6	3.6	3.6	3.6
All-Red Time (s)	1.9	1.9	2.0	1.9	3.2
Lost Time Adjust (s)					
Total Lost Time (s)					
Lead/Lag	Lag	Lag	Lag	Lead	
Lead-Lag Optimize?	Yes	Yes	Yes	Yes	
Vehicle Extension (s)	4.0	3.0	4.0	4.0	4.0
Recall Mode	None	Min	None	Min	None
Act Effect Green (s)					
Actuated g/C Ratio					
v/c Ratio					
Control Delay					
Queue Delay					
Total Delay					
LOS					
Approach Delay					
Approach LOS					
Intersection Summary					

Attachment E-4 – Synchro Analysis
2045 PM

Lanes, Volumes, Timings
68: I-49 SB Ramp & 163rd St

07/10/2020

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	1004	242	146	548	0	0	0	0	533	0	759
Future Volume (vph)	0	1004	242	146	548	0	0	0	0	533	0	759
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	390		0	0		0	0		0	285		340
Storage Lanes	2		0	1		0	0		0	1		1
Taper Length (ft)	110			0			0			120		
Lane Util. Factor	1.00	0.86	0.86	1.00	0.95	1.00	1.00	1.00	1.00	0.97	1.00	1.00
Frt		0.966										0.850
Flt Protected				0.950						0.950		
Satd. Flow (prot)	0	6190	0	1770	3539	0	0	0	0	3433	0	1583
Flt Permitted				0.950						0.950		
Satd. Flow (perm)	0	6190	0	1770	3539	0	0	0	0	3433	0	1583
Right Turn on Red			Yes			Yes				Yes		Yes
Satd. Flow (RTOR)		77										155
Link Speed (mph)		35			35			40			40	
Link Distance (ft)		630			335			800			1284	
Travel Time (s)		12.3			6.5			13.6			21.9	
Peak Hour Factor	0.92	0.94	0.76	0.75	0.90	0.92	0.92	0.92	0.92	0.91	0.92	0.91
Adj. Flow (vph)	0	1068	318	195	609	0	0	0	0	586	0	834
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	1386	0	195	609	0	0	0	0	586	0	834
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Right	Left	Right
Median Width(ft)		20			20			24			24	
Link Offset(ft)		0			0			0			0	
Crosswalk Width(ft)		16			16			16			16	
Two way Left Turn Lane												
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Turning Speed (mph)	15		9	15		9	15		9	15		9
Number of Detectors		1		1	1					1		1
Detector Template		Thru		Left	Thru					Left		Right
Leading Detector (ft)		30		30	30					30		30
Trailing Detector (ft)		0		0	0					0		0
Detector 1 Position(ft)		0		0	0					0		0
Detector 1 Size(ft)		30		30	30					30		30
Detector 1 Type		Cl+Ex		Cl+Ex	Cl+Ex					Cl+Ex		Cl+Ex
Detector 1 Channel												
Detector 1 Extend (s)		0.0		0.0	0.0					0.0		0.0
Detector 1 Queue (s)		0.0		0.0	0.0					0.0		0.0
Detector 1 Delay (s)		0.0		0.0	0.0					0.0		0.0
Turn Type		NA		Prot	NA					Prot		Perm
Protected Phases		6		5	5 6					7		
Permitted Phases												7
Detector Phase		6		5	5 6					7		7
Switch Phase												
Minimum Initial (s)		12.0		10.0						6.0		6.0
Minimum Split (s)		17.5		15.6						12.8		12.8
Total Split (s)		26.1		16.5						47.4		47.4

Lanes, Volumes, Timings
68: I-49 SB Ramp & 163rd St

07/10/2020

Lane Group	Ø1	Ø2	Ø3	Ø4
Lane Configurations				
Traffic Volume (vph)				
Future Volume (vph)				
Ideal Flow (vphpl)				
Storage Length (ft)				
Storage Lanes				
Taper Length (ft)				
Lane Util. Factor				
Frt				
Flt Protected				
Satd. Flow (prot)				
Flt Permitted				
Satd. Flow (perm)				
Right Turn on Red				
Satd. Flow (RTOR)				
Link Speed (mph)				
Link Distance (ft)				
Travel Time (s)				
Peak Hour Factor				
Adj. Flow (vph)				
Shared Lane Traffic (%)				
Lane Group Flow (vph)				
Enter Blocked Intersection				
Lane Alignment				
Median Width(ft)				
Link Offset(ft)				
Crosswalk Width(ft)				
Two way Left Turn Lane				
Headway Factor				
Turning Speed (mph)				
Number of Detectors				
Detector Template				
Leading Detector (ft)				
Trailing Detector (ft)				
Detector 1 Position(ft)				
Detector 1 Size(ft)				
Detector 1 Type				
Detector 1 Channel				
Detector 1 Extend (s)				
Detector 1 Queue (s)				
Detector 1 Delay (s)				
Turn Type				
Protected Phases	1	2	3	4
Permitted Phases				
Detector Phase				
Switch Phase				
Minimum Initial (s)	6.0	12.0	6.0	4.0
Minimum Split (s)	11.5	17.6	12.8	16.0
Total Split (s)	18.1	24.5	25.4	22.0

Attachment E-4 – Synchro Analysis
2045 PM

Lanes, Volumes, Timings
68: I-49 SB Ramp & 163rd St

07/10/2020

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Total Split (%)		29.0%		18.3%						52.7%		52.7%
Maximum Green (s)		20.6		10.9						40.6		40.6
Yellow Time (s)		3.6		3.6						3.6		3.6
All-Red Time (s)		1.9		2.0						3.2		3.2
Lost Time Adjust (s)		0.0		0.0						0.0		0.0
Total Lost Time (s)		5.5		5.6						6.8		6.8
Lead/Lag		Lead		Lag								
Lead-Lag Optimize?		Yes		Yes								
Vehicle Extension (s)		4.0		4.0						4.0		4.0
Recall Mode		Min		None						None		None
Act Effect Green (s)		20.6		10.9	37.0					40.6		40.6
Actuated g/C Ratio		0.23		0.12	0.41					0.45		0.45
v/c Ratio		0.94		0.91	0.42					0.38		1.04
Control Delay		45.7		72.4	11.0					17.2		65.9
Queue Delay		0.0		0.0	0.6					0.0		0.0
Total Delay		45.7		72.4	11.5					17.2		65.9
LOS		D		E	B					B		E
Approach Delay		45.7			26.3						45.8	
Approach LOS		D			C						D	

Intersection Summary

Area Type: Other

Cycle Length: 90

Actuated Cycle Length: 90

Natural Cycle: 100

Control Type: Actuated-Uncoordinated

Maximum v/c Ratio: 1.04

Intersection Signal Delay: 41.4

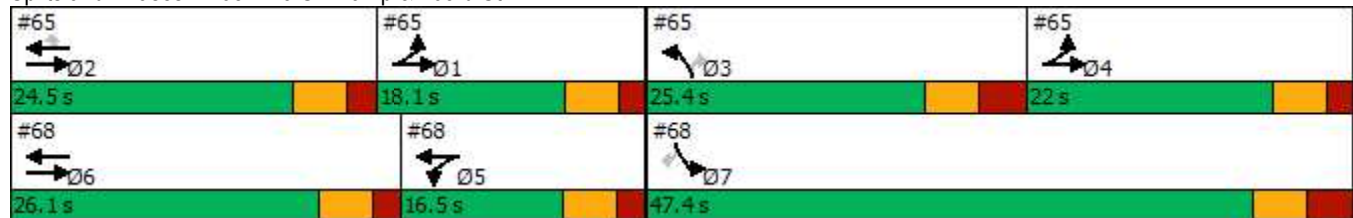
Intersection LOS: D

Intersection Capacity Utilization 102.3%

ICU Level of Service G

Analysis Period (min) 15

Splits and Phases: 68: I-49 SB Ramp & 163rd St



Lanes, Volumes, Timings
68: I-49 SB Ramp & 163rd St

07/10/2020

Lane Group	Ø1	Ø2	Ø3	Ø4
Total Split (%)	20%	27%	28%	24%
Maximum Green (s)	12.6	18.9	18.6	16.5
Yellow Time (s)	3.6	3.6	3.6	3.6
All-Red Time (s)	1.9	2.0	3.2	1.9
Lost Time Adjust (s)				
Total Lost Time (s)				
Lead/Lag	Lag	Lead	Lead	Lag
Lead-Lag Optimize?	Yes	Yes	Yes	Yes
Vehicle Extension (s)	4.0	4.0	4.0	3.0
Recall Mode	None	Min	None	Min
Act Effect Green (s)				
Actuated g/C Ratio				
v/c Ratio				
Control Delay				
Queue Delay				
Total Delay				
LOS				
Approach Delay				
Approach LOS				
Intersection Summary				